COMPARATIVE STUDY OF TOOTH SIZE AND ARCH DIMENSIONS IN CLASS I CROWDED, PROCLINED MALOCCLUSION AND CLASS I NORMAL OCCLUSION

Dissertation Submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

in Partial fulfilment for the degree of

MASTER OF DENTAL SURGERY

BRANCH - V
ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS
APRIL – 2013

CERTIFICATE

This is to certify that the dissertation entitled **"comparative study of tooth size and arch dimensions in class I crowded, proclined malocclusion and class I normal occlusion"** by **Dr. D.DHAYANITHI,** Post graduate student (M.D.S), Orthodontics (branch V), Tamil Nadu Govt. Dental College and Hospital, Chennai, submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfilment for the M.D.S. degree examination (April 2012) is a bonafide research work carried out by him under my supervision and guidance.

DR. G. VIMALA M.D.S.,
Professor
Dept. of Orthodontics and dentofacial orthopaedics,
Tamil Nadu Govt Dental College & Hospital,
Chennai - 600 003.

Dr. M.C.SAINATH M.D.S.,
Professor and Head of the Department,
Dept. of Orthodontics&dentofacial orthopaedics
Tamil Nadu Govt Dental College & Hospital,
Chennai - 600 003.

Dr. K. S. G. A. NASSER M.D.S.,
Principal
Tamil Nadu Govt Dental College&Hospital.
Chennai- 600 003.

DECLARATION

I, Dr. D.DHAYANITHI , do hereby declare that the dissertation titled "COMPARATIVE STUDY OF TOOTH SIZE AND ARCH DIMENSIONS IN CLASS I CROWDED, PROCLINED MALOCCLUSION AND CLASS I NORMAL OCCLUSION" was done in the Department of Orthodontics, Tamil Nadu Government Dental College & Hospital, Chennai 600 003. I have utilized the facilities provided in the Government Dental College for the study in partial fulfilment of the requirements for the degree of Master of Dental Surgery in the speciality of Orthodontics and Dentofacial Orthopaedics (Branch V) during the course period 2010-2013 under the conceptualization and guidance of my dissertation guide, Professor Dr. G. VIMALA MDS.

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

Signature of the PG student   Signature of the HOD

Signature of the Head of the Institution

ACKNOWLEDGMENT

My sincere thanks to Dr. K.S.G.A. NASSER, M.D.S., Principal, Tamil Nadu Government Dental College and Hospital, Chennai-3, for his kind support and encouragement.

I owe my thanks and great honour to Dr. M.C. SAINATH M.D.S, Professor, Head of the Department, Department of Orthodontics and Dentofacial Orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai3, for helping me with his valuable and timely suggestions and encouragement.

I express my deep sense of gratitude and great honour to my respected guide, Professor Dr. G. VIMALA M.D.S., Department of Orthodontics and Dentofacial orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai-3, for her patience guidance, support and encouragement throughout the study.

I owe my thanks and great honour to Dr. S. PREMKUMAR M.D.S, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Tamilnadu Govt. Dental College and Hospital, Chennai3, for helping me with his valuable and timely suggestions and encouragement.

I am grateful to Dr. B. BALASHANMUGAM, M.D.S., Assistant Professor, Department of Orthodontics, Tamil Nadu Government Dental College and Hospital, Chennai –3 for his support and encouragement.

I am grateful to Dr. USHA RAO, M.D.S., Assistant Professor, Department of Orthodontics, Tamilnadu Government Dental College and Hospital, Chennai-3 for her support and encouragement.

I am grateful to Dr. K. USHA, M.D.S., Assistant Professors, Department of Orthodontics, Tamil Nadu Government Dental College and Hospital, Chennai –3 for her support and encouragement.

I thank Mr. K. BOOPATHI M.Sc., M.Phil. For helping me with the Statistics in the study.

I take this opportunity to express my gratitude to my friends and colleagues for their valuable help and suggestions throughout this study.

I offer my heartest gratitude to my family members for their selfless blessings.

I seek the blessings of the Almighty God without whose benevolence; the study would not have been possible.

TRIPARTITE AGREEMENT

This agreement herein after the “Agreement” is entered into on this day............... day of December 2012 between the Tamil Nadu Government Dental College and Hospital represented by its **Principal** having address at Tamilnadu Government Dental college and Hospital, Chennai-03, (hereafter referred to as , ’the college’)

And

Dr. G. VIMALA aged 44 years working as professor at the college, having residence address at AP 115, 5th Street, AF Block, 11th Main Road, Anna Nagar, Chennai, Pin: 600 040, Tamilnadu (herein after referred to as the ‘Principal investigator’)

And

Dr. D.DHAYANITHI, aged 34 years currently studying as postgraduate student in department of Orthodontics in Tamilnadu Government Dental College and Hospital (herein after referred to as the ‘PG/Research student and co- investigator’).

Whereas the ‘PG/Research student as part of his curriculum undertakes to research on **“comparative study of tooth size and arch dimensions in class I crowded, proclined malocclusion and class I normal occlusion**” for which purpose the PG/Principal investigator shall act as principal investigator and the college shall provide the requisite infrastructure based on availability and also provide facility to the PG/Research student as to the extent possible as a Co-investigator.

Whereas the parties, by this agreement have mutually agreed to the various issues including in particular the copyright and confidentiality issues that arise in this regard.

Now this agreement witnesseth as follows:

1. The parties agree that all the Research material and ownership therein shall become the vested right of the college, including in particular all the copyright in the literature including the study, research and all other related papers.

2. To the extent that the college has legal right to do go, shall grant to licence or assign the copyright do vested with it for medical and/or commercial usage of interested persons/entities subject to a reasonable terms/conditions including royalty as deemed by the college.

3. The royalty so received by the college shall be equally by all the parties.

4. The PG/Research student and PG/Principal Investigator shall under no circumstances deal with the copyright, Confidential information and know – how generated during the course of research/study in any manner whatsoever, while shall sole vest with the manner whatsoever and for any purpose without the express written consent of the college.

5. All expenses pertaining to the research shall be decided upon by the principal investigator/Co-investigator or borne sole by the PG/research student. (Co-investigator)

6. The college shall provide all infrastructure and access facilities within and in other institutes to the extent possible. This includes patient interactions, introductory letters, recommendation letters and such other acts required in this regard.

7. The principal investigator shall suitably guide the student Research right from selection of the Research Topic and Area till its completion. However the selection and conduct of research, topic and area research by the student researcher under guidance from the principal investigator shall be subject to the prior approval, recommendations and comments of the Ethical Committee of the college constituted for this purpose.

8. It is agreed that as regards other aspects not covered under this agreement, but which pertain to the research undertaken by the student Researcher, under guidance from the Principal Investigator, the decision of the college shall be binding and final.

9. If any dispute arises as to the matters related or connected to this agreement herein, it shall be referred to arbitration in accordance with the provisions of the Arbitration and Conciliation Act, 1996.

In witness whereof the parties hereinabove mentioned have on this the day month and year herein above mentioned set their hands to this agreement in the presence of the following two witnesses.

College represented by its **Principal** **PG Student**

Witnesses **Student Guide**

1.

2.

CONTENTS

List of tables

List of charts

ABSTRACT

Background: Prevalence of dental crowding has shown a steady rise in the modern population. An effective treatment mode to eliminate malocclusion involves clear understanding of its etiology. Various studies reported so far correlating malocclusion with tooth size- arch dimension discrepancy. This current study would find the correlation between dental malocclusions like crowding and proclination with variables like tooth size and arch dimensions.

Aim: purpose of this study to compare the extent and to find whether it is arch dimension or tooth size that contributes to a greater extent to malocclusions like dental crowding and proclination.

Methods: Three groups of dental casts were selected. Each group consisted of 30 models (15 male and 15 females). The Following measurement were obtained and compared between groups. Lrgest mesiodistal width of each tooth on each arch, Buccal inter-canine and inter-molar widths, Lingual inter-canine and inter-molar widths, Arch perimeters, Arch length, Anterior and overall Bolton ratios.

Results: The findings revealed that the mesiodistal tooth dimensions were significantly higher in crowded and proclination group than uncrowded group. In arch dimensions maxillary inter canine and inter molar width were reduced in crowded group. Arch perimeter and arch length were higher in proclination group.

Conclusion: The mesiodistal teeth dimensions were significantly higher in crowded and proclination group. Both inter canine width and inter molar width of maxilla were significantly reduced in crowded group than uncrowded and proclination groups. Maxillary and mandibular arch perimeter and arch lengths were significantly increased in proclination group than crowded and uncrowded group.

KEYWORDS:Arch dimension, Tooth width, Crowding, Proclination

INTRODUCTION

Prevalence of dental crowding has shown a steady rise in the modern population. An effective treatment mode to eliminate malocclusion involves clear understanding of its etiology. Etiology of malocclusion is multifactorial. 5% of factors are known while the rest are yet to be unravelled. Local and general causes are among known contributing factors.

It is evident from two large scale epidemiological studies conducted by United States public health services[65] that class I malocclusion with crowding or proclination form the single large group of malocclusions.

There is complex interrelationship between mesiodistal crown widths, various arch dimensions and primary dental crowding as reported in previous studies. Reason for crowding and proclination are complex and various explanations have been offered.

Amidst various studies reported so far correlating malocclusion with tooth size- arch dimension discrepancy, studies exploring level of contribution of each of factors like arch length, arch width and teeth dimensions in causing dentoalveolar malocclusion are incongruous, not throwing adequate light to unravel the query.

Purpose of this study therefore, was to locate which of the following factors, namely, arch dimension such as inter canine alveolar widths(buccal and lingual), intermolar alveolar widths(buccal and lingual), arch perimeter, arch length and mesiodistal tooth dimensions contribute maximum to malocclusions such as crowding and proclinations.

AIM AND OBJECTIVES

AIM:

To compare the extent and to find whether it is arch dimension or tooth size that contributes to a greater extent to malocclusions like dental crowding and proclination.

OBJECTIVES:

1. To compare the mesiodistal tooth dimensions between crowded, proclined and uncrowded dentition.
2. To compare the arch dimensions such as arch widths in canine and molar region, arch perimeter, arch length between crowded, proclined and uncrowded dentition.
3. To compare the Bolton's anterior and overall ratios between crowded proclined and uncrowded dentition.

REVIEW OF LITERATIURE

Norman Thomas Speck,(1950)[56] Studied the developmental changes in human lower dental arches and concluded that the dental arch form changed during the transition from complete deciduous to permanent dentition.

Bolton (1958)[9]**,** analyzed group of 55 excellent occlusions. He introduced mathematical tooth size ratios, which were supposed to be helpful in diagnosis and treatment planning. Bolton concluded that these ratios should be 2 of the tools used in orthodontic diagnosis, allowing the orthodontist to gain insight into the functional and esthetic outcome of a given case.

In a subseqeuent paper in **1962, Bolton**[8] expanded on the clinical application of his tooth size analysis. Bolton’s standard deviations from his original sample have been used to determine need for reduction of tooth tissue by interdental stripping or the addition of tooth material by restorative techniques.

Frohlich (1961)[25] compared intercanine and intermolar widths of maxillary and Mandibular arches of children with Class II malocclusion, with data collected by Moorrees (1959) from children with normal occlusion. He found that the absolute arch widths of the Class II children did not differ appreciably from those of children with normal occlusion.

Lorren F. Mills (1964)[38]**,** Studied the Arch width, arch length and tooth size in young adult males. Results indicated a significant association exists between malalignment of teeth and arch width. Arch length mesial to second molar did not vary in persons with and without malalignment.

Robert H. Biggerstaff (1967)[68] studied the anterior migration of dentitions and anterior crowding and concluded that, anterior crowding was caused by a number of intrinsic (endogenous or hereditary) and extrinsic (exogenous or environmental) factors. Intrinsic factors include an incompatible relationship between arch size and tooth size, tooth position in the arch and differential growth of the maxilla and the mandible. The extrinsic factors include abnormal habits, mutilation of the dentition and abnormal muscular function.

Jorge Fastlicht (1970)[23] did a study to clarify the cause of mandibular crowding. Author concluded that, the larger the mesiodistal width of the incisors, the greater the crowding will be, if there is a lack of proportion. Maxillary and mandibular incisors were larger in males. Crowding of the mandibular incisors was more noticeable in males. The third molars were not related to crowding of the incisors. Age was a positive but secondary factor in crowding of the incisors. In general, the values and differences of the variables between sexes turned out to be more regular and significant in females. Positional changes of teeth were noted to be less in the maxilla than in the mandible.

C. L. B. LAVELLE, T. D. FOSTER, R. M. FLINN, (1971)[11] studied Dental Arches in Various Ethnic Groups. The groups examined were

Caucasoid (modern British), Mongoloid (North American Indian), Negroid (New Guinean and West African) and Australoid (Australian aboriginal). Authors concluded that there was no consistent trend of the dental arch dimensions from one population sample being greater than those from another.

VIRGINIA B. Knott (1972)[91], Sillman JH (1964)[78], Samir E Bishra et al (1996)[71], jan Hendrickson(2001)[32],Nikolaos Tsiopas (2011)[53], longitudinally studied the dental arch widths changes of dentition. They concluded that, maxillary and mandibular widths decreased from the mixed dentition stage to young adulthood stage. Little change in intercanine width was occurring after permanent dentition stage. In the mandibular arch, intercanine width occurred largely before the eruption of the permanent canine teeth.

C. L. B. LAVELLE (1973)[10] studied the Secular Changes in the Teeth and Dental Arches. Study of 150 Caucasoid families, comparison between parents and offspring showed a secular increase in the dimensions of the teeth, but a secular decrease in the dimensions of the dental arches. This emphasizes the complexity of secular trends.

T. D. Foster, M. C. Gnrndy, and C. Lavelle (1977)[80] studied the dental arch growth and concluded that, in the arches anterior to the first permanent molars, peaks of growth occur between 2 and 3 years and 7 and 8 years in the maxilla, and between 2 and 3 years and 5 and 6 years in the mandible. In the arches, including the first permanent molars, peaks of growth occur between 6 and 8 years in the maxilla and between 9 and 10 years in the mandible.

John M. Doris, Brentley W. Bernard, and Mladen M. Kuftinec, (1981)[34] did biometric study of tooth size and dental crowding. Authors compared mesiodistal tooth widths between a group of patients with good tooth alignment and a group of patients with crowded dental arches. On the basis of their study, they suggested that one should consider the sum of mesiodistal widths of teeth, in addition to the arch length analysis, in formulating an orthodontic treatment plan. When the cumulative tooth mass of the twenty permanent teeth is 140 mm. or more, the clinician may want to consider extraction therapy for such a case.

Howe R.P., McNamara, O'Connor KA. (1983)[31] did examination of dental crowding and its relationships to tooth size and arch dimensions. A study was done to assess the contribution of tooth size and jaw size towards dental crowding. The results of this study suggested that consideration to be given to those treatment techniques which increase dental arch length rather than reduced tooth mass.

Staley et al (1985)[79]**,** compared the arch widths of normal occlusion, Class II, Division 1, evaluated the maxillary arch width dentally (by measuring the maxillary intermolar and intercanine widths) and skeletally (by measuring the maxillary interalveolar width i.e. the distance between the mucogingival junctions above the mesiobuccal cusp tips of the maxillary right and left permanent first molars). They found that the maxillary intermolar width, intercanine width and interalveolar width were significantly greater in the Class I group than the Class II, Division 1 group. They suggested that the narrow widths of the maxillary dental arch in the Class II group appeared to be caused by palatal movement of the maxillary posterior teeth and also by the narrow bony bases of the dental arch. The palatal movement of the maxillary posterior teeth in Class II patients was needed to compensate for the increased buccal overjet and for good posterior interdigitation. In the subjects with normal occlusion, males had significantly larger dimensions than females in five of the six arch width measurements, whereas among the Class II, Division 1 subjects, males had larger dimensions than females with no significant differences except in maxillary and mandibular interalveolar widths.

Nagwa Helmy El-Mangoury, Soheir M. Gaafar, Yehya A. Mostafa (1987)[51] studied the association between mandibular anterior crowding and periodontal Disease. They concluded that the gingival index was higher in the presence of crowding. The plaque index tends to return to its original pretreatment value much faster in a crowded lower anterior segment.

D. Radnzlc (1988)[16] investigated the correlation among cumulative mesiodistal crown widths, arch dimensions, and the degree of primary dental arch crowding in two ethnic groups which are indigenous British and Pakistani immigrant groups to determine whether similar correlations existed as part of a larger study of ethnic comparisons. This study suggested a complex interrelationship among cumulative mesiodistal crown widths, the various arch dimensions, and primary dental crowding.

Carl-Magnus Forsberg (1988)[12] conducted a study to evaluate relationship of eruption or impaction of third molars with spacing and crowding. Author stated that, the dental arches in the extraction group tended to be more crowded than in the group with complete dentitions.

Samar E. Bishara, Jane R. Jakobsen, Jean E. Treder, and Mark J. Stasi, (1989)[73] studied the Changes in the maxillary and mandibular Tooth size-arch length relationship from early adolescence to early adulthood. They concluded that the changes in the alignment of the teeth are primarily the result of a decrease in the available arch length in the maxillary and mandibular arches. These changes were not significantly related to any one dental or facial variable; the cause was multi-factorial and was associated with changes in facial height, overbite, incisor inclination, arch dimensions, and the mesiodistal diameter of various teeth.

Toshihiro Yoshihara ,Yuko Matsumoto, Junichi Suzuki, Naoshi Sato, Haruhisa Oguchi,(1991)[85] studied the effect of serial extraction alone on crowding and relationships between tooth width, arch length, and crowding. Maxillary dental casts from 32 subjects who had undergone only serial extraction were analyzed at 3 stages: before deciduous canines extraction, after first premolars extraction, and at the end of the observation period. The mean of the irregularity index decreased significantly as serial extraction proceeded and further decreased during the observation period.

Mary Lynn Merz et al, (1991)[44] did a study to test the hypothesis that, black patients have larger mesiodistal tooth diameters and larger dental arch perimeters than a corresponding sample of white patients. They concluded that, black patients had wider and deeper dental arches. They also had larger mesiodistal tooth dimensions than white patients. The black sample also had a larger mean MP-SN angle but this was not accompanied by the increased crowding and the narrower dental arches that had been reported associated with high-angle white samples.

Monique Raberin, Bernard Laumon, Jean-Louis Martin,' and Frangois Brunner (1993)[48] studied the dimensions and form of dental arches in subjects with normal occlusions. In the study six measurements of the mandibular dental arches were performed, and five independent ratios, were determined. Based on this study, five mandibular dental arch forms were defined, and an arch guide was developed. The proposed mandibular arch forms were 1) narrow 2) wide, 3) mid, 4) pointed 5) flat. The dental arches of the women have smaller dimensions.

P.H.Buschang P.H., Stroud J. Alexander RG. (1994)[61], Studied the differences in dental arch morphology among adult females with untreated class I and class II malocclusions. The results showed that both maxillary and mandibular dental arch size were significantly larger for the younger age group, arch shape was relatively shorter and wider for the oldest age group. Subjects with class II malocclusions had significantly smaller arch.

Margaret E. Richardson (1995)[42] studied the role of transverse dimension on late lower arch crowding and concluded that the increase in lower arch crowding between 13 and 18 years was not related to tooth width, arch width, or jaw width, actual or relative, or to changes in these dimensions.

W. Craig Shellhart, D. William Lange, G. Thomas Kluemper, E. Preston Hicks, Alan L. Kaplan, (1995)[92]studied the reliability of the Bolton tooth-size analysis when applied to crowded dentitions. The results of this study demonstrated that clinically significant measurement errors can occur when the Bolton tooth-size analysis is performed on casts that have at least 3 mm of crowding. The size and frequency of these errors evidenced considerable inter-individual variation.

McCann and Burden (1996)[45] examined tooth size in a sample of Northern Irish people with bimaxillary dental protrusion. Measurements were made directly on the dental casts by a single operator using calliper. The results revealed that, on average, tooth size for the overall maxillary and mandibular dentition was 5.7% larger in the bimaxillary group than in the control group.

E. Bishara, Paymun Bayati and Jane R. Jakobsen, (1996)[73] did a study to determine on a longitudinal basis whether the growth trends in maxillary and mandibular dental arch widths and lengths in persons with Class II, Division 1 malocclusions were different from those of normal subjects. They stated that, the changes in arch lengths and widths in both the subjects with Class II, Division 1 malocclusions and the normal subjects follow the same general patterns.

Otuyemi and Noar (1996)[60] compared the mesio-distal and bucco-lingual crown dimensions of the permanent teeth in Nigerian and British populations. The results indicated that the mesiodistal crown diameters were significantly larger in the Nigerian sample. There were no statistically significant differences in bucco-lingual crown diameters in the two populations, except for the mandibular central incisors and maxillary canines.

Yuen *et al.* (1997)[93] studied the relations between the mesio-distal crown diameters of the primary and permanent teeth of Hong Kong Chinese. For size differences, results revealed that the incisors and canines were larger in the permanent dentition in both arches. Premolars were smaller than their primary predecessors except for the upper first premolar. The second premolar-second primary molar differences were the greatest while those between the first premolar-first primary molar were the smallest. When tooth groups were assessed, the permanent teeth were larger than their predecessors in the anterior segments but smaller in the posterior segments. The leeway space was larger in the mandibular arch than in the maxillary arch.

Samir E Bishara et al, (1998)[70] studied the arch length changes from 6 weeks to 45 years of life. They concluded that, greatest incremental increase was occurring in first two years of life. Arch length continues to increase until 13 years in maxilla and until 8 years in mandible.

Gary A. Carter, and James A. McNamara, Jr, (1998)[27] examined the changes in the dental arches that occur in untreated persons between late adolescence and the fifth or sixth decade of life. Dental arch width, arch depth, and arch perimeter were evaluated with the aid of digital-imaging hardware and software. They concluded that, at all times, males displayed significantly more mandibular incisor irregularity than females.

Kevin M. Cassidy, Edward F. Harris, Elizabeth A. Tolley, Robert G. Kelm, (1998)[35] studied the genetic influence on dental arch form in orthodontic patients. Study concluded that, arch size has a modest genetic component, on the order of 50%, although this estimate may contain shared environmental influences.

Seung-Hoon Rhee and Dong-Seok Nahm, (2000)[77] studied the correlation between the shape of the labial crowns of the incisors and crowding. They concluded that the prevalence of crowding was higher in individuals with triangularly shaped incisors. The width ratio of the incisors (IMD/CMD) is correlated with the irregularity index. Therefore, the width ratio of the incisors can be a useful tool in the diagnosis, treatment, and retention protocol of crowded malocclusion.

Benjamin G. Burris, Edward F. Harris, (2000)[7] studied quantified differences in arch size and shape in 2 constituents (blacks and whites) of the

US population. Authors concluded that, blacks had greater arch width than whites, and blacks had greater intercanine and intermolar width than whites. Arch perimeter was greater in blacks.

Todd M. Walkow and Sheldon Peck, (2002)[83] studied the Dental arch width in Class II Division 2 deepbite malocclusion. They concluded that, the posterior arch widths in the maxilla and the mandible of II/2 cover-bite patients are the same as those of other orthodontic patients. Therefore, transverse maxillomandibular discrepancies would not be suspected as a cause of II/2 deep-bite malocclusions.

Becker *et al.* (2002)[6] investigated the relation between the palatally displaced Canine and the existence of a reduction in the size of the other teeth in the maxilla. The results indicated that the teeth of males with palatally displaced canine were reduced in size. They stated that, the mesiodistal width of teeth in females with bilateral palatally displaced canine was smaller than the mesio-distal width in females with unilateral palatally displaced canine. The reverse was true for the bilateral palatally displaced canine males, where a larger mesio-distal width was seen, compared with the unilateral palatally displaced canine males.

Anthony A. Gianelly (2003)[3] did a study to find arch width changes between extraction and non-extraction orthodontic treatment. They concluded that, in both groups, anterior and posterior arch widths were the same except for the mandibular intercanine dimension, which was 0.94 mm larger in the extraction group. This indicated that extraction treatment did not result in narrower dental arches than nonextraction treatment.

Santoro *et al.* (2003)[74] performed a study to compare the accuracy of measurements made by the OrthoCAD system on digital models with measurements made by hand on traditional plaster models. Tooth size was measured on the digital models with the analysis tools provided by OrthoCAD, as well as for measuring the overjet and overbite. The results showed a statistically significant difference between the 2 groups for tooth size and overbite, with the digital measurements being smaller than the manual measurements.

Oded Zilberman et al (2003)[57] did a study to test the accuracy of measuring casts with the aid of callipers or OrthoCAD and compared these two techniques. They concluded that, measurement with digital callipers on plaster models showed the highest accuracy and reproducibility, closely followed by OrthoCAD.

Christopher J. Lux, Christian Conradt, Donald Burden, Gerda Komposch, (2003)[14] analysed the transverse morphology and development of the dental arches and skeletal mandibular-maxillary bases in untreated Class II malocclusions. They concluded that class II div 1 malocclusion had smaller maxillary basal widths, maxillary intermolar widths and exhibited largest molar differences than class I groups.

Anwar Ali Shah, Claire Elcock, and Alan H. Brook, (2003)[4] investigated correlations between the shape of mandibular incisor crowns and crowding.

Study models of 50 untreated white subjects with varying degrees of crowding were studied. The lower incisors were sectioned and imaged at the contact point and midpoint levels, and the mesiodistal width was measured. Crowding was quantified by using both Little's irregularity index and anterior tooth size-arch length discrepancy. They suggested that no predictors of lower incisor crowding could be established from mandibular incisor crown shape.

Saglam *et al.* (2004)[69] compared the mesio-distal crown dimensions of the permanent teeth between subjects with and without fluorosis. The results indicated that the mesio-distal crown dimensions were larger in subjects with non-fluorotic permanent teeth. On the other hand there was no difference in the mandibular mesio-distal crown diameters for any of the measurements except for the mandibular first premolars.

Eduardo Bernabe et al (2004)[19] compared the tooth width ratios in crowded and non-crowded dentition. They concluded that, Differences among subjects with noncrowded and crowded dentitions were of 0.39 and 0.51 mm for the excess of anterior and total upper tooth mass, respectively, with respect to lower mass excess. Although the anterior and overall ratios and the differences between the upper and lower tooth width sums were greater in subjects with crowding, no clinically significant difference was observed.

Pete E. Lestrel, Osamu Takahashi, and Eisaku Kanazawa, (2004)[63] applied the elliptical Fourier functions (EFF) to compare the shape of crowded and uncrowded dental arches, matched for size and sex. This Study has demonstrated the usefulness of EFFs for numerically describing the shape of structures in the craniofacial complex, specifically the maxilla and mandibular arches. The use of EFFs has clearly displayed the differences between sexes as well as an asymmetrical pattern of crowding in the dental arches.

Raquel H. W. Tibana, Lisiane Meira Palagi, Augusto M. Miguel, (2004)[67] evaluated the longitudinal changes in occlusal dimensions in young adults. They concluded that, a significant overbite increase was found, as well as increases in the irregularities of the upper and lower incisors. Arch perimeter of both arches and lower intercanine and intermolar widths showed significant decrease. Positive correlations were found between the upper intercanine width and the lower arch perimeter and between the upper and lower arch perimeters.

M. Ozgur Sayin, Hakan Turkkahraman, (2004)[40] did a study to identify the possible factors contributing to mandibular anterior crowding in the early mixed dentition. The results indicated that a significant correlations between crowding and total incisor width, available space, intercanine width, permanent intermolar width, and interalveolar width. No significant correlation was found between crowding and total arch length.

M. Ozgur Sayin, Hakan Turkkahraman, (2004)[41] conducted a study to evaluate malocclusion and crowding in orthodontically referred Turkish population. The study concluded that, Class I was the most frequently seen malocclusion, whereas Class II, division 2 was the least common. Comparison of the mean ages of a referred malocclusion group indicated statistically significant difference between Class I and Class II, division 1 groups. Mild mandibular crowding was the most common finding, whereas severe mandibular crowding was the least one in all malocclusion groups.

Sercan Akyalcın, Servet Dog, Banu Dincer, Aslıhan Mediha Ertan Erdinc, Gokhan O ncag, (2005)[76]analyzed Bolton tooth Size discrepancies in skeletal Class I individuals presenting with different Angle dentoalveolar classifications. Study investigated the frequency and association of Bolton tooth size discrepancies with dental discrepancies. They concluded that, Molar relationships did not relate to intermaxillary tooth size discrepancies. A Bolton's anterior and overall ratio discrepancy did not affect the occlusion in this manner.

Khalaf *et al.* (2005)[36] performed a study to compare tooth size measurements between patients with supernumerary teeth and a control group. Results showed that supernumerary tooth patients tended to have larger tooth size measurements for almost all variables compared to controls. They stated that there is some evidence of a local effect with greater differences in tooth dimension adjacent to the site of the supernumeraries.

Eduardo Bernabé, César Eduardo Del Castillo and Carlos Flores-Mir (2005)[20] did a study to find Intra-arch occlusal indicators of crowding in the permanent dentition. They concluded that, although tooth-size and arch dimensions were indicators of crowding, arch length was the most important factor.

Tancan Uysal, Badel Memili, Serdar Usumez, Zafer Sari(2005)[81] compared the transverse dimensions of the dental arches and alveolar arches in the canine, premolar, and molar regions of Class II division 1 and Class II division 2 malocclusion groups with normal occlusion subjects. The study concluded that the maxillary interpremolar width, canine and premolar alveolar widths, and all mandibular alveolar widths were significantly narrower in the Class II division 2 group than in the normal occlusion sample. The mandibular intercanine and interpremolar widths were narrower and the maxillary intermolar width measurement was larger in the Class II division 2 subjects when compared with the Class II division 1 subjects.

Guvenc Basaran, Murat Selek, Orhan Hamamcı, Zeki Akkus¸ (2006)[30] studied the Intermaxillary Bolton Tooth Size Discrepancies among Different Malocclusion Groups. The results showed no significant difference between subcategories of malocclusion, so these groups were combined as Class I, Class II, and Class III. No significant difference was found for all the ratios between the groups.

Eduardo Bernabe, Carlos Flores-Mirb (2006)[21] conducted a study to compare, combined and individually, the mesiodistal (MD) and buccolingual (BL) tooth sizes as well as their respective crown proportions in the permanent dentition in dental arches with moderate, mild, and no crowding. They concluded that Dental arches with moderate, mild, and no crowding differ most of the times significantly in their mesiodistal tooth sizes and crown proportions individually or combined but not in their buccolingual tooth sizes.

Noriko Shigenobua; Masataka Hisanob; Sachiko Shimac; Nozomu Matsubarad; Kunimichi Somae (2006)[55] conducted a study to investigate the patterns of dental crowding in the lower arch and their contributing morphological and functional factors. They concluded that, the prevalence of dental crowding was highest in the anterior region and was related to the same tooth on each side (right lateral incisor vs. left lateral incisor). In the premolar and molar region, the prevalence of dental crowding was related to the adjacent tooth (right first premolar vs. second premolar). Three crowding patterns were found in the anterior region: (1) a symmetry pattern, (2) a rotation pattern, and (3) an irregular pattern.

Qiong Nie and Jiuxiang Lin (2006)[66] used euclidean distance matrix analysis to compare dental arch forms between subjects with Class II Division 1 malocclusions and normal occlusions. The results showed that arch forms in maxillary Class II Division 1 subjects significantly differed from subjects with normal occlusions in both size and shape regardless of sex, and posterior areas contribute most to the arch-form difference.

Toru Kageyama, Gladys Cristina Domínguez-Rodríguez, Julio Wilson Vigorito, and Toshio Deguchi (2006)[84] evaluated dental arch forms associated with various facial types in adolescents with Class II Division 1 malocclusions by using mathematical functions to describe the arch form at clinical bracket points. Fifteen landmarks on dental cast were digitized. Computer-generated mathematical arch forms (fourth-degree polynomial equation and beta function) were used to evaluate arch form differences by superimposition. Authors concluded that the beta function is appropriate for predicting the finishing arch form, and the polynomial equation is appropriate for the analysis (diagnosis) of various Class II malocclusions, including ovoid, tapered, and square arch forms and dental arch asymmetry.

Fahad F. H. Al SuIaimani and Ahmed Rami Afify (2006)[22] compared the Bolton ratios for a Saudi Arabian sample of different classes of malocclusion and also studied to find any gender difference. Results were no significant differences of Bolton anterior and overall ratios between Angle's Class I, Class II, and Class III malocclusions. There was no sexual dimorphism in Bolton anterior and overall ratios for the combined three classes of malocclusion.

Navgeet Puri, Kusum Lata Pradhan, Anil Chandna, Vikas Sehgal and Rajiv Gupta (2007)[52] Biometrically studied the tooth size to examine the extent to which tooth size contributes to dental crowding or spacing. They concluded that Mesiodistal tooth size was an important factor in the assessment of crowding or spacing and in orthodontic treatment planning.

Joel Huth, R.Newton Staley, Richard Jacobs, Jane jackobson, (2007)[33] compared Arch widths in class II division 2 adults with class II division 1 and normal occlusion. Comparison showed class II group had maxillary arch width significantly smaller than normal occlusions. The class II division 2 and class II division 1 had similar mandibular inter molar width and smaller than normal occlusions.

Olav Bondevik(2007)[58], compared changes in arch width and length in high- and low-angle Subjects. He concluded that, there was an ongoing change in upper and lower arch form from 23 to 33 years of age. For both genders, there is a reduction in arch length, a decrease in width in the canine area, and an increase in the molar area in both arches, a decrease of the anterior perimeters and a decrease of the anterior space condition.

Omar Gabriel da Silva Filho, Fla´vio Mauro Ferrari, Ju´ niorTerumi Okada Ozawa, (2007)[59] studied the dental arch dimensions in Class II division I Malocclusions with Mandibular Deficiency, to test the hypothesis that there is no difference in the dimensions of the upper and lower dental arches in Class II division 1 malocclusion with a mandibular deficiency compared to normal Class I occlusion dental arches. They rejected hypothesis. Significant differences were present between the dimensions of the upper and lower dental arches in Class II division 1 malocclusion (with a mandibular deficiency and in the permanent dentition) compared to normal Class I occlusion dental arches.

Valerie Ronay, R. Matthew Miner, Leslie A. Will and Kazuhito Arai (2008)8[9] investigated mandibular dental arch form at the levels of both the clinically relevant application points of the orthodontic bracket and the underlying anatomic structure of the apical base. Mandibular dental casts (skeletal and dental Class I) were laser scanned, and a 3-dimensional virtual model was created. Two reference points (FA, the most prominent part of the central lobe on each crown’s facial surface, and WALA, a point at the height of the mucogingival junction) were selected for each tooth from the right to the left first molars. The FA and WALA arch forms were compared, and the distances between corresponding points and intercanine and intermolar widths were analyzed and concluded that both FA and WALA point-derived arch forms were individual and therefore could not be defined by a generalized shape. WALA points proved to be a useful representation of the apical base and helpful in the predetermination of an individualized dental arch form.

Seba AlHarbi, Eman A. Alkofide, Abdulaziz AlMad (2008)[75] presented a comprehensive mathematical analysis of dental arch curvature in subjects with normal occlusion. They concluded that the fourth-order polynomial was found to be a reasonable function to fit the dental arch when the objective was to describe the general smooth curvature of the arch.

Timothy R. Kuntz, Robert N. staley, Herold F. Bigelow, Charles R. Kremenak, Frank J. Kohout, Jane R .Jackobsen(2008)[82], Compared Arch width in adults with class I crowded and class III malocclusions compared with normal occlusions. They concluded that the hypothesis of no difference between adults with class I crowding, class III and class I normal occlusions with respect to 1) arch widh,2) width of maxillary and mandibular arches, 3)gender dimorphism and 4)gender comparisons was rejected by the findings of this study.

V. Paulino et al (2008)[88] did a study to predict the arch length (AL) based on inter canine width (ICW). They concluded that, a high correlation between AL and ICW was found for both arches. This Correlation makes it possible to predict the size of one of the variables by knowing the size of the other. For an increase of 1 mm of ICW, the AL increases approximately 1.36 mm with 95 per cent CI (1.30 – 1.42).

Francesco Pachı et al (2009)[24] studied lower arch crowding in relation to head posture. They concluded that, there was a clear pattern of association between extended head posture and lower arch dental crowding.

Toshiya Endo, Kenji Uchikura, Katsuyuki Ishida, Isao Shundo, Kosuke Sakaeda,Shohachi Shimooka,(2009)[86]**,** did a study to determine an appropriate threshold for clinically significant tooth-size discrepancy using both a Bolton standard deviation (SD) definition and a millimetric definition. They concluded that the tooth-size discrepancies could be better expressed in terms of both percentage and actual amount of millimeters required for correction. The ratios outside 2 SDs from the Bolton mean and the discrepancies requiring more than 2 mm of maxillary and/or mandibular corrections are recommendable as the appropriate thresholds for clinical significance.

Michael K. Agenter, Edward F. Harris, and Robert N. Blair (2009)[47] studied the Influence of tooth crown size on malocclusion. Suggested that tooth size is not necessarily the foremost cause of malocclusion in a patient, but it should be evaluated.

Deepak Gupta, R. Matthew Miner, Kazuhito Arai, and Leslie A. (2010)[18] Investigated the mandibular arch form at the levels of both the application point of the orthodontic bracket and the basal bone in adults and children with Class I malocclusion and Class II Division 1 malocclusion. They concluded that, the Class II Division 1 mandible is essentially the same as the Class I mandible with respect to basal bone and dental arch dimensions. WALA points can be used to predict individual dental arch forms in adults and children. Dental and basal arch forms were not significantly different between adolescents and adults.

Martina Slaj, Stjepan Spalj, Dubravko Pavlin, Davor Illes,Mladen Slaj(2010)[43]did a study to test the hypothesis that no differences exist in dental arch dimensions between dentoalveolar Classes I, II, and III, and between male and female subjects, as measured on virtual three-dimensional (3D) models. They rejected the hypothesis and concluded that the dimensions of the dental arches are related to gender and to dentoalveolar class. Class I and II subjects have similar dimensions of maxillary dental arch, but Class II subjects have a transverse deficit in the mandible. In Class III subjects, the maxillary dental arch is insufficient in transverse and sagittal dimensions.

Tung Yuen Ting, Ricky Wing Kit Wong and A Bakr M.Rabie (2011)[87] analyzed the genetic polymorphisms in skeletal class I crowding in hongkong Chinese population. Their study suggested an association for the genes EDA and XEDAR in dental crowding in the Hong Kong Chinese population.

Guilherme Janson, Oscar Edwin Francisco Murillo Goizueta, Daniela G. Garib, Marcos Janson (2011)[29] studied the relationship between maxillary and mandibular effective lengths and dental crowding in patients with Class II malocclusions. They concluded that decreased maxillary and mandibular effective lengths constitute an important factor associated with dental crowding in patients with complete Class II malocclusion.

Loomba et al. (2011)[37] compared the arch perimeter between bimaxillary protrusion, crowded and in normal occlusion. They concluded that, Arch perimeter in class I bimaxillary and crowding cases was significantly more in upper and lower arches when compared to normal occlusion and increase in arch perimeter was more related to the underlying dentition.

David Normando (2011)[17] evaluated the reliability and validity of measurements obtained from clinical standardized occlusal photographs compared with dental cast measurements. He concluded that, With the exception of the mesio-distal width of the upper first molar, the photogrammetric method was a reliable instrument for clinical and scientific application to measure dental arch dimensions and tooth size.

MATERIALS AND METHODS

Samples were obtained from the records available in Department of orthodontics and dentofacial orthopaedics, Tamilnadu Government dental college & hospital, Chennai. 90 pre-treatment models were selected from records of 90 patients (45 males and 45 females). The samples were divided into three groups namely: Group A, Group B and Group C. Each group consisted of 30 models (15 male and 15 females). The age group of samples were between 18 to 24 years.

Records were checked for the following criteria:

Inclusion criteria:

1. Good general health
2. Permanent dentition.
3. Normal sizes, shape, form of teeth.

Exclusion criteria

1) Dentition with missing teeth.
2) Dentition with supernumary teeth.
3) Dentition with proximal restorations on teeth.
4) History of orthodontic treatment.
5) Trauma or surgeries done in dentofacial region.

Grouping:

Group A) – Uncrowded group, (30 samples):

1) Bilateral Angle’s class I molar relationship.
2) Well aligned maxillary and mandibular arches. If spacing or crowding were present, they were less than 2mm.
3) Normal overjet and overbite relationship.
4) No anterior or posterior open bite.
5) No anterior or posterior crossbite.

Group B) - Crowded group (30 samples):

1) Bilateral Angle’s class I molar relationship.
2) Crowding of 5mm or more in both upper and lower arches.
3) No anterior or posterior open bite.
4) No anterior or posterior crossbite.

Group C) - Proclination group (30 samples):

1) Bilateral Angle’s class I molar relationship.
2) Proclined upper and lower dental arches with acceptable alignment of teeth.
3) No anterior or posterior openbite.
4) No anterior or posterior crossbite.

ARMAMENTARIUM:

1) Digital vernier calliper (Aerospace, china) to measure mesiodistal width of tooth and alveolar width. The calliper was calibrated to 0.1 mm for measurements.
2) Scanner (Hp G2410 Scanjet flatbed scanner) to scan the models.

MEASUREMENTS:

The Following measurement were obtained,

1) The largest mesiodistal width of each tooth on each arch (except the second and third molars)
2) Buccal inter-canine and inter-molar widths
3) Lingual inter-canine and inter-molar widths
4) Arch perimeters
5) Arch length
6) Anterior and overall Bolton ratios

1) Mesiodistal Tooth width:

The calliper was held on buccal side and measured at largest mesiodistal width.

2) Buccal intercanine and intermolar width

Mesiodistal centre points at the cervical margins on buccal side of canines and first molars on either side were marked. A point was marked 5 mm apical to the above mentioned point. Using digital calliper, the buccal inter-canine and inter-molar arch widths[31,64] were measured as the distance between the two apical points on buccal side of both canine and molar regions of the right and left side respectively.

3) Lingual inter-canine and inter-molar widths:

'Lingual inter-canine and inter-molar widths' were measured as the distance between midpoints on the lingual cervical region of canines and molars on either side respectively, using digital calliper.

4) Arch perimeters:

An arch perimeter is a line drawn from the distal surface of the first permanent molar around the arch over the contact points and incisal edges in a smooth curve to the distal surface of the first permanent molars on the opposite side. To draw the curve, dental casts with contact point markings were scanned by Hp G2410 Scanjet flatbed scanner and arch perimeters were measured using Auto-CAD software (Autodesk inc, san Rafael, CA, USA) from scanned copies of dental casts.

5) Arch length:

A line touching distal surfaces of first molars on either side was drawn. The perpendicular distance between this line and midpoint between incisal edges of central incisors was measured as the arch length.

6) Bolton's ratio:

Bolton's anterior and overall ratios were calculated for each sample by using following formula, Overall ratio =

$$\frac{\text{Sum of mesiodistal widths of mandibular 12 teeth (first molar-first molar)}}{\text{Sum of mesiodistal widths of maxillary 12 teeth (first molar-first molar)}} \times 100$$

Anterior ratio =

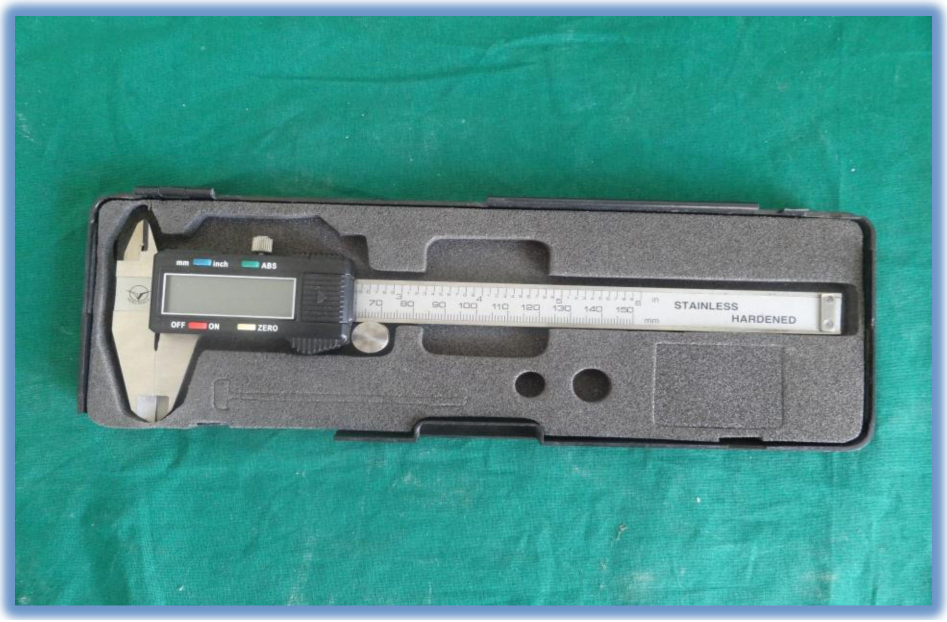
$$\frac{\text{Sum of mesiodistal widths of mandibular anterior 6 teeth (canine to canine)}}{\text{Sum of mesiodistal widths of maxillary anterior 6 teeth (canine to canine)}} \times 100$$

DATA ANALYSIS:

All the data obtained were analysed using SPSS® software (SPSS Inc., Chicago, IL, USA), and the one way ANOVA test was used to compare the groups and Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons between each group was done.

ARMAMENTARIUM

Digital vernier calliper

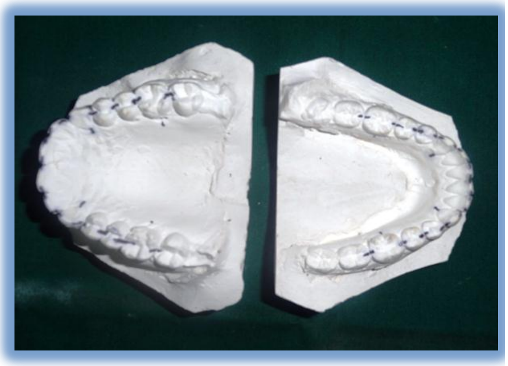


Hp Scanjet scanner

SAMPLES

GROUP A SAMPLE MODEL



GROUP B SAMPLE MODEL





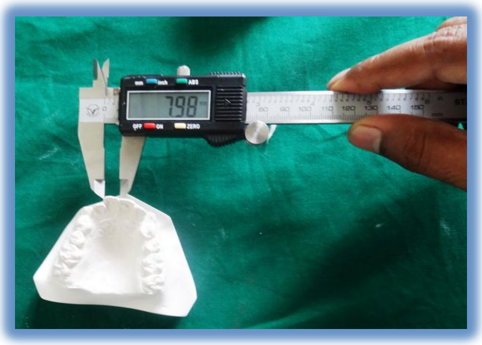

GROUP C SAMPLE MODEL





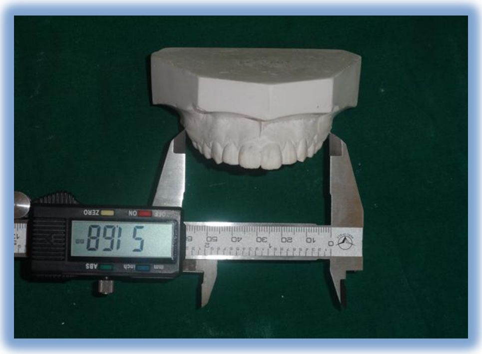

<u>METHOD OF MEASURING</u>

Mesiodistal Tooth Width

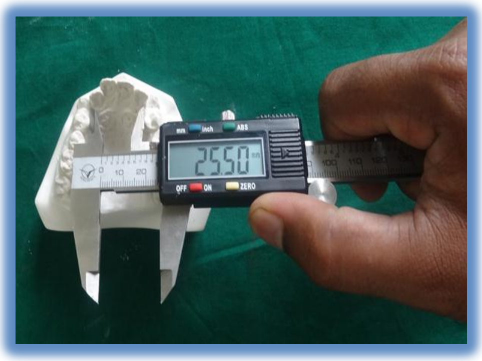


Buccal Intercanine width

Buccal inter molar width

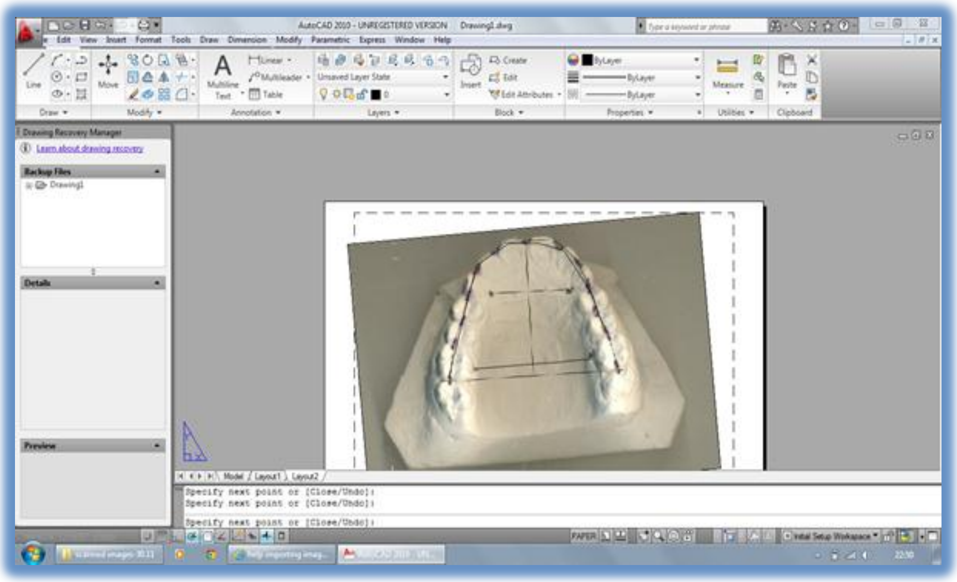


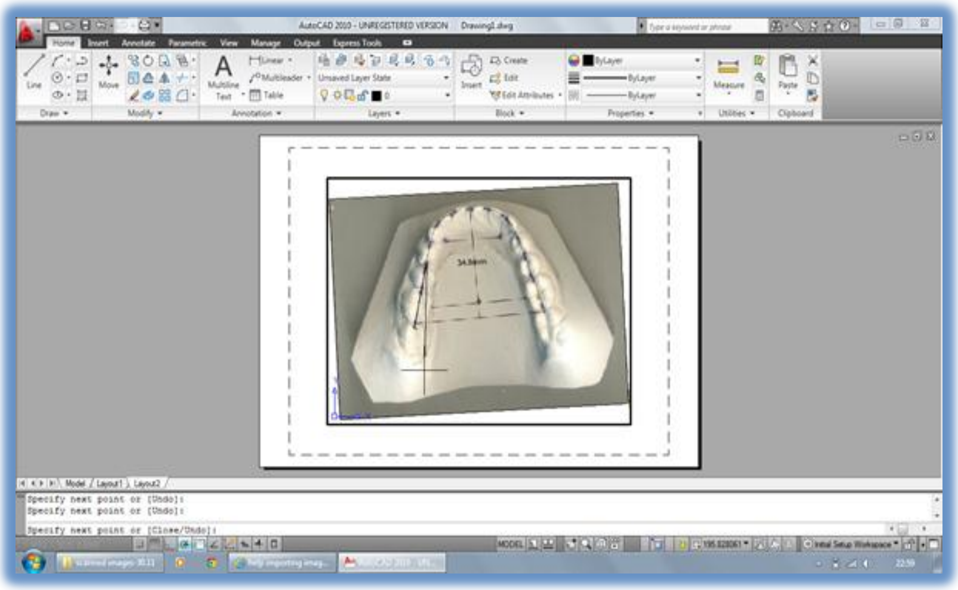
Lingual inter canine width



Lingual inter molar width

Measuring Arch length and Arch perimeter





RESULTS

This study was done to find the correlation between dental malocclusions like crowding and proclination with variables like tooth size and arch dimensions. Mesiodistal widths of all teeth from first molar on one side to that on the other side were measured for both maxillary and mandibular arches. Buccal inter canine and inter molar widths, lingual inter canine and inter molar widths, arch lengths and arch perimeters were measured. Bolton's anterior and overall ratios were calculated.

The following comparisons between Group A (Uncrowded), Group B (Crowded) and Group C (Proclination) and inferences were made:

1) Mesiodistal tooth dimensions:

Table 1 shows the comparison of collective mesiodistal teeth width of 6 anterior and total 12 teeth (first molar on one side to first molar on contra lateral side) in both maxillary and mandibular arches between Group A, B and C, which revealed that the mesiodistal tooth dimensions were significantly higher in crowded (Group B) and proclination group (Group C).

Comparison of tooth widths between both the genders was also done **(Table 2 & Table 3)** the differences in tooth width was observed.

Table 4 shows Multiple pair wise Comparisons of sum of six anterior and total 12 teeth in maxillary and mandibular arches between each groups.

2) Comparison of buccal and lingual intercanine widths of maxillary and mandibular arches:

Table 5 shows the comparison of buccal and lingual intercanine widths of maxillary and mandibular arches between Group A, B and C, which revealed that, widths were significantly reduced in crowded (Group B) than uncrowded (Group A) and proclination (Group C) group. Same results were observed in both genders **(Table 6 & Table 7).** .

Table 8 shows the multiple pair wise comparisons of buccal and lingual inter canine width of maxillary and mandibular arches between each group.

3) Comparison of buccal and lingual intermolar widths of maxillary and mandibular arches:

Table 9 shows the comparison of buccal and lingual inter molar widths of maxillary and mandibular arches between groups. Maxillary intermolar (buccal & lingual) width significantly reduced in crowded (Group B) group than uncrowded (Group A) and proclination (Group C) group. Both males and females showed same results **(Table 10 & Table 11).**

Table 12 shows the multiple pair wise comparisons of buccal and lingual inter molar width of maxillary and mandibular arches between each group.

4) Comparison of arch perimeter and arch length of both maxillary and mandibular arches:

Table 13 shows the comparison of arch perimeter and arch length of both maxillary and mandibular arches between groups. Maxillary and mandibular arch perimeter significantly increased in proclination (Group C) group than crowded (Group B) and uncrowded (Group A) group. Maxillary and mandibular arch length also significantly increased in proclination (Group C) group than crowded (Group B) and uncrowded group (Group A). Same results were observed in both males and females **(Table 14 & Table 15)**.

Table 16 shows the multiple pair wise comparisons of arch perimeter and arch length of maxillary and mandibular arches between each group.

5) Comparison of Bolton's anterior and overall ratios:

Table 17 shows the comparison of Bolton's anterior and overall ratios between groups. There was a difference in Bolton's anterior ratio in crowded (Group B) and proclination (Group C) group compared with uncrowded (Group A) group. Overall ratio between groups A, B and C were not significant. In both crowded and proclined group mild anterior mandidibular tooth material excess was present. Same results were observed in both genders **(Table 18 & Table 19).**

Table 20 shows the multiple pair wise comparisons of Bolton's anterior and overall ratios between each group.

Table 1:

One way ANOVA test for comparison of mean values of maxillary and mandibular six anterior and total 12 teeth between groups.

Variables	Groups	N	Mean	Std. Dev	Min	Max	P-Value
Sum of max 6 anteriors	Group A	30	45.24	1.343	43	48	<0.001
	Group B	30	48.81	1.152	46	51	
	Group C	30	48.76	1.364	47	52	
	Total	90	47.60	2.112	43	52	
Sum of max 12 teeth	Group A	30	91.97	1.690	88	95	<0.001
	Group B	30	98.38	1.788	95	102	
	Group C	30	99.19	1.788	96	104	
	Total	90	96.51	3.681	88	104	
Sum of mand 6 anteriors	Group A	30	35.80	1.369	33	39	<0.001
	Group B	30	38.10	0.895	36	40	
	Group C	30	37.89	0.848	37	40	
	Total	90	37.26	1.483	33	40	
Sum of mand 12 teeth	Group A	30	84.29	2.419	79	88	<0.001
	Group B	30	90.38	2.550	86	95	
	Group C	30	90.53	2.681	86	95	
	Total	90	88.40	3.863	79	95	

Table 2:

One way ANOVA test for comparison of mean values of maxillary and mandibular six anterior and total 12 teeth between groups in males.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Sum of max 6 anteriors	Group A	15	45.89	1.385	44	48	<0.001
	Group B	15	48.85	1.322	46	51	
	Group C	15	49.01	1.617	47	52	
	Total	45	47.92	2.027	44	52	
Sum of max 12 teeth	Group A	15	92.77	1.639	90	95	<0.001
	Group B	15	98.98	1.849	96	102	
	Group C	15	99.59	2.253	96	104	
	Total	45	97.12	3.642	90	104	
Sum of mand 6 anteriors	Group A	15	36.61	1.043	35	39	<0.001
	Group B	15	38.45	.780	37	40	
	Group C	15	38.33	.890	37	40	
	Total	45	37.80	1.229	35	40	
Sum of mand 12 teeth	Group A	15	85.88	1.599	83	88	<0.001
	Group B	15	91.97	2.268	89	95	
	Group C	15	92.30	2.279	89	95	
	Total	45	90.05	3.607	83	95	

Table 3:

One way ANOVA test for comparison of mean values of maxillary and mandibular six anterior and total 12 teeth between groups in females.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Sum of max 6 anteriors	Group A	15	44.59	.955	43	46	<0.001
	Group B	15	48.77	1.000	47	50	
	Group C	15	48.51	1.053	47	50	
	Total	45	47.29	2.171	43	50	
Sum of max 12 teeth	Group A	15	91.17	1.361	88	93	<0.001
	Group B	15	97.77	1.555	95	100	
	Group C	15	98.79	1.097	97	101	
	Total	45	95.91	3.662	88	101	
Sum of mand 6 anteriors	Group A	15	34.98	1.170	33	37	<0.001
	Group B	15	37.75	.885	36	39	
	Group C	15	37.45	.538	37	39	
	Total	45	36.73	1.534	33	39	
Sum of mand 12 teeth	Group A	15	82.69	2.032	79	85	<0.001
	Group B	15	88.80	1.718	86	92	
	Group C	15	88.75	1.720	86	92	
	Total	45	86.75	3.407	79	92	

Table 4:

Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons of sum of six anterior and total 12 teeth in maxillary and mandibular arches between groups.

Variable	Pairs		Mean Diff	Sig.
Sum of max 6 anteriors	Group A	Group B	-3.577	<0.001
		Group C	-3.523	<0.001
	Group B	Group C	0.053	0.986
Sum of max 12 teeth	Group A	Group B	-6.403	<0.001
		Group C	-7.220	<0.001
	Group B	Group C	-0.817	0.175
Sum of mand 6 anteriors	Group A	Group B	-2.303	<0.001
		Group C	-2.093	<0.001
	Group B	Group C	0.210	0.726
Sum of mand 12 teeth	Group A	Group B	-6.097	<0.001
		Group C	-6.240	<0.001
	Group B	Group C	-0.143	0.974

Table 5:

One way ANOVA test for comparison of the mean values of buccal and lingual inter canine widths of maxillary and mandibular arches between groups.

Variables	Groups	N	Mean	Std. Dev	Min	Max	P-Value
Max buccal inter canine width	Group A	30	38.11	1.330	36	42	<0.001
	Group B	30	34.82	0.967	34	37	
	Group C	30	37.81	1.254	36	41	
	Total	90	36.91	1.906	34	42	
Mand buccal intercanine width	Group A	30	31.87	1.527	29	35	<0.001
	Group B	30	29.55	1.293	27	33	
	Group C	30	31.59	1.406	29	34	
	Total	90	31.00	1.741	27	35	
Max lingual inter canine width	Group A	30	26.20	0.725	24	28	<0.001
	Group B	30	23.74	1.031	22	25	
	Group C	30	25.93	0.793	24	28	
	Total	90	25.29	1.395	22	28	
Mand lingual inter canine width	Group A	30	19.81	0.792	18	21	0.538
	Group B	30	19.58	0.933	18	21	
	Group C	30	19.61	0.820	18	21	
	Total	90	19.67	0.847	18	21	

Table 6:

One way ANOVA test for comparison of the mean values of buccal and lingual inter canine widths of maxillary and mandibular arches between groups in males.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Max buccal inter canine width	Group A	15	38.87	1.101	37	42	<0.001
	Group B	15	35.16	1.085	34	37	
	Group C	15	38.43	1.069	37	41	
	Total	45	37.48	1.980	34	42	
Mand buccal intercanine width	Group A	15	32.84	1.122	31	35	<0.001
	Group B	15	29.97	1.524	28	33	
	Group C	15	32.35	1.155	31	34	
	Total	45	31.72	1.781	28	35	
Max lingual inter canine width	Group A	15	26.23	.966	24	28	<0.001
	Group B	15	24.14	.831	22	25	
	Group C	15	26.07	.997	24	28	
	Total	45	25.48	1.326	22	28	
Mand lingual inter canine width	Group A	15	20.35	.622	19	21	0.476
	Group B	15	20.04	.783	19	21	
	Group C	15	20.15	.659	19	21	
	Total	45	20.18	.687	19	21	

Table 7:

One way ANOVA test for comparison of the mean values of buccal and lingual inter canine widths of maxillary and mandibular arches between groups in females.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Max buccal inter canine width	Group A	15	37.36	1.113	36	39	<0.001
	Group B	15	34.47	.713	34	36	
	Group C	15	37.19	1.140	36	39	
	Total	45	36.34	1.661	34	39	
Mand buccal intercanine width	Group A	15	30.90	1.248	29	33	<0.001
	Group B	15	29.13	.876	27	31	
	Group C	15	30.83	1.238	29	33	
	Total	45	30.29	1.383	27	33	
Max lingual inter canine width	Group A	15	26.16	.391	25	27	<0.001
	Group B	15	23.34	1.081	22	25	
	Group C	15	25.78	.512	25	26	
	Total	45	25.09	1.449	22	27	
Mand lingual inter canine width	Group A	15	19.27	.537	18	20	0.692
	Group B	15	19.13	.862	18	21	
	Group C	15	19.06	.564	18	20	
	Total	45	19.15	.661	18	21	

Table 8:

Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons of buccal and lingual inter canine widths of maxillary and mandibular arches between groups.

Variable	Pairs		Mean Diff	Sig.
Max buccal inter canine width	Group A	Group B	3.297	<0.001
		Group C	0.303	0.589
	Group B	Group C	-2.993	<0.001
Mand buccal intercanine width	Group A	Group B	2.320	<0.001
		Group C	0.280	0.724
	Group B	Group C	-2.040	<0.001
Max lingual inter canine width	Group A	Group B	2.457	<0.001
		Group C	0.270	0.447
	Group B	Group C	-2.187	<0.001
Mand lingual inter canine width	Group A	Group B	0.223	0.568
		Group C	0.200	0.635
	Group B	Group C	-0.023	0.994

Table 9:

One way ANOVA test for comparison of the mean values of buccal and lingual inter molar widths of maxillary and mandibular arches between groups.

Variables	Groups	N	Mean	Std. Dev	Min	Max	P-Value
Max buccal inter molar width	Group A	30	60.59	2.240	57	64	<0.001
	Group B	30	57.22	1.057	55	59	
	Group C	30	60.05	2.152	56	65	
	Total	90	59.29	2.392	55	65	
Mand buccal inter molar width	Group A	30	57.34	1.694	55	61	0.678
	Group B	30	57.00	1.873	54	62	
	Group C	30	57.00	1.661	54	60	
	Total	90	57.11	1.733	54	62	
Max lingual inter molar width	Group A	30	35.75	1.347	34	39	<0.001
	Group B	30	33.40	1.210	32	36	
	Group C	30	35.64	1.351	33	38	
	Total	90	34.93	1.686	32	39	
Mand lingual inter molar width	Group A	30	33.16	1.158	31	35	0.235
	Group B	30	32.64	1.483	30	36	
	Group C	30	32.95	1.222	30	35	
	Total	90	32.58	1.448	30	36	

Table 10:

One way ANOVA test for comparison of the mean values of buccal and lingual inter molar widths of maxillary and mandibular arches between groups in males.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Max buccal inter molar width	Group A	15	61.87	1.825	59	64	<0.001
	Group B	15	57.35	1.019	56	59	
	Group C	15	61.17	1.840	58	65	
	Total	45	60.13	2.549	56	65	
Mand buccal inter molar width	Group A	15	58.45	1.296	56	61	0.492
	Group B	15	58.42	1.312	57	62	
	Group C	15	57.93	1.345	56	60	
	Total	45	58.27	1.309	56	62	
Max lingual inter molar width	Group A	15	36.25	1.196	35	39	<0.001
	Group B	15	34.19	1.081	33	36	
	Group C	15	36.12	1.043	35	38	
	Total	45	35.52	1.441	33	39	
Mand lingual inter molar width	Group A	15	33.67	.868	33	35	0.022
	Group B	15	32.55	1.571	31	36	
	Group C	15	33.51	.886	33	35	
	Total	45	33.24	1.236	31	36	

Table 11:

One way ANOVA test for comparison of the mean values of buccal and lingual inter molar widths of maxillary and mandibular arches between groups in females.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Max buccal inter molar width	Group A	15	59.31	1.885	57	62	0.001
	Group B	15	57.08	1.112	55	59	
	Group C	15	58.93	1.875	56	62	
	Total	45	58.44	1.901	55	62	
Mand buccal inter molar width	Group A	15	56.24	1.287	55	58	0.354
	Group B	15	55.58	1.109	54	57	
	Group C	15	56.06	1.425	54	58	
	Total	45	55.96	1.282	54	58	
Max lingual inter molar width	Group A	15	35.25	1.338	34	37	<0.001
	Group B	15	32.61	.725	32	34	
	Group C	15	35.15	1.481	33	37	
	Total	45	34.34	1.720	32	37	
Mand lingual inter molar width	Group A	15	32.64	1.205	31	35	<0.001
	Group B	15	30.73	.559	30	32	
	Group C	15	32.38	1.273	30	34	
	Total	45	31.92	1.346	30	35	

Table 12:

Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons of buccal and lingual inter molar widths of maxillary and mandibular arches between groups.

Variable	Pairs		Mean Diff	Sig.
Max buccal inter molar width	Group A	Group B	3.377	<0.001
		Group C	0.547	0.506
	Group B	Group C	-2.830	<0.001
Mand buccal inter molar width	Group A	Group B	0.343	0.727
		Group C	0.347	0.723
	Group B	Group C	0.003	1.000
Max lingual inter molar width	Group A	Group B	2.343	<0.001
		Group C	0.110	0.943
	Group B	Group C	-2.233	<0.001
Mand lingual inter molar width	Group A	Group B	0.520	0.516
		Group C	0.210	0.805
	Group B	Group C	-1.310	0.001

Table 13:

One way ANOVA test for comparison of the mean values of arch perimeter and arch length of maxillary and mandibular arches between groups.

Variables	Groups	N	Mean	Std. Dev	Min	Max	P-Value
Maxillary arch perimeter	Group A	30	99.30	2.499	93	103	<0.001
	Group B	30	98.53	2.281	95	103	
	Group C	30	104.22	1.590	100	107	
	Total	90	100.68	3.315	93	107	
Mandibular arch perimeter	Group A	30	90.23	2.114	84	94	<0.001
	Group B	30	89.53	2.072	84	92	
	Group C	30	93.52	1.102	92	96	
	Total	90	90.69	2.839	84	96	
Maxillary arch length	Group A	30	36.42	1.388	34	39	<0.001
	Group B	30	37.13	1.082	35	39	
	Group C	30	42.27	1.339	40	46	
	Total	90	38.61	2.911	34	46	
Mandibular arch length	Group A	30	32.49	0.813	30	34	<0.001
	Group B	30	31.76	1.275	29	35	
	Group C	30	36.08	1.254	34	38	
	Total	90	33.44	2.204	29	38	

Table 14:

One way ANOVA test for comparison of the mean values of arch perimeter and arch length of maxillary and mandibular arches between groups in males.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Maxillary arch perimeter	Group A	15	100.99	.869	100	103	<0.001
	Group B	15	100.10	1.787	98	103	
	Group C	15	105.19	1.211	104	107	
	Total	45	102.09	2.598	98	107	
Mandibular arch perimeter	Group A	15	90.98	.830	90	92	<0.001
	Group B	15	89.65	1.620	87	92	
	Group C	15	94.06	1.133	92	96	
	Total	45	91.56	2.224	87	96	
Maxillary arch length	Group A	15	37.10	1.211	35	39	<0.001
	Group B	15	37.29	1.133	35	39	
	Group C	15	42.65	1.524	40	46	
	Total	45	39.01	2.897	35	46	
Mandibular arch length	Group A	15	32.67	.642	32	34	<0.001
	Group B	15	31.92	1.636	29	35	
	Group C	15	36.44	1.305	34	38	
	Total	45	33.68	2.351	29	38	

Table 15:

One way ANOVA test for comparison of the mean values of arch perimeter and arch length of maxillary and mandibular arches between groups in females.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Maxillary arch perimeter	Group A	15	97.61	2.457	93	103	<0.001
	Group B	15	96.95	1.509	95	100	
	Group C	15	103.26	1.336	100	106	
	Total	45	99.27	3.378	93	106	
Mandibular arch perimeter	Group A	15	89.49	2.715	84	94	<0.001
	Group B	15	86.95	1.756	84	90	
	Group C	15	92.99	.784	92	94	
	Total	45	89.81	3.127	84	94	
Maxillary arch length	Group A	15	35.73	1.235	34	39	<0.001
	Group B	15	36.98	1.045	35	38	
	Group C	15	41.89	1.039	40	44	
	Total	45	38.20	2.900	34	44	
Mandibular arch length	Group A	15	32.31	.943	30	34	<0.001
	Group B	15	31.60	.796	30	33	
	Group C	15	35.71	1.127	34	38	
	Total	45	33.21	2.045	30	38	

Table 16:

Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons arch perimeter and arch lengths of maxillary and mandibular arches between groups.

Variable	Pairs		Mean Diff	Sig.
Maxillary arch perimeter	Group A	Group B	0.773	0.352
		Group C	-4.923	<0.001
	Group B	Group C	-5.697	<0.001
Mandibular arch perimeter	Group A	Group B	0.728	0.167
		Group C	-3.290	<0.001
	Group B	Group C	-5.220	<0.001
Maxillary arch length	Group A	Group B	-0.717	0.081
		Group C	-5.857	<0.001
	Group B	Group C	-5.140	<0.001
Mandibular arch length	Group A	Group B	0.730	0.038
		Group C	-3.587	<0.001
	Group B	Group C	-4.317	<0.001

Table 17:

One way ANOVA test for comparison of the mean values of Bolton's anterior and overall ratios between groups.

Variables	Groups	N	Mean	Std. Dev	Min	Max	P-Value
Bolton ant ratio	Group A	30	76.03	2.785	73	79	<0.001
	Group B	30	78.08	1.032	77	79	
	Group C	30	78.09	1.003	77	79	
	Total	90	77.40	2.036	73	79	
Over all ratio	Group A	30	91.85	0.507	91	93	0.532
	Group B	30	91.64	0.871	91	93	
	Group C	30	91.67	0.852	91	93	
	Total	90	91.72	0.759	91	93	

Table 18:

One way ANOVA test for comparison of the mean values of Bolton's anterior and overall ratios between groups in males.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Bolton ant ratio	Group A	15	78.77	.140	79	79	<0.001
	Group B	15	79.09	.092	79	79	
	Group C	15	79.07	.111	79	79	
	Total	45	78.97	.186	79	79	
Over all ratio	Group A	15	92.33	.080	92	93	0.584
	Group B	15	92.44	.080	92	93	
	Group C	15	92.51	.080	92	93	
	Total	45	92.44	.112	92	93	

Table 19:

One way ANOVA test for comparison of the mean values of Bolton's anterior and overall ratios between groups in females.

Variable	Group	N	Mean	Std. Dev	Min	Max	P - value
Bolton ant ratio	Group A	15	73.30	.185	73	74	<0.001
	Group B	15	77.07	.105	77	77	
	Group C	15	77.11	.110	77	77	
	Total	45	75.82	1.810	73	77	
Over all ratio	Group A	15	91.37	.180	91	92	0.572
	Group B	15	90.79	.083	91	91	
	Group C	15	90.84	.091	91	91	
	Total	45	91.00	.292	91	92	

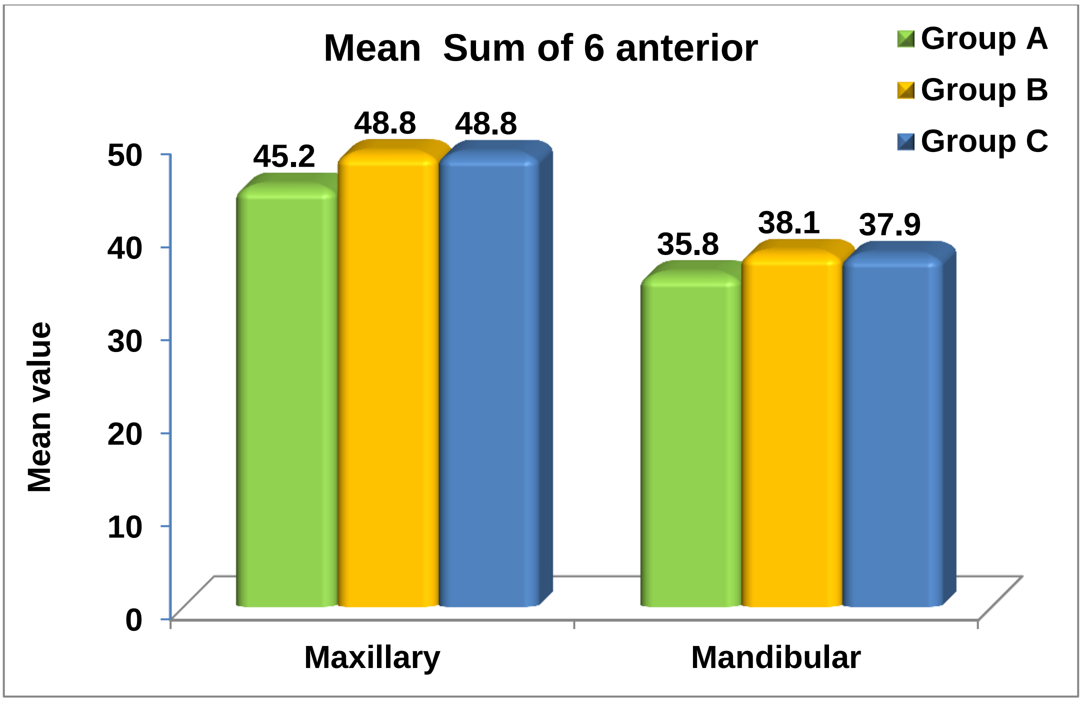
Table 20:

Tukey HSD Post Hoc Tests for Multiple pair wise Comparisons of Bolton's anterior and overall ratios between groups.

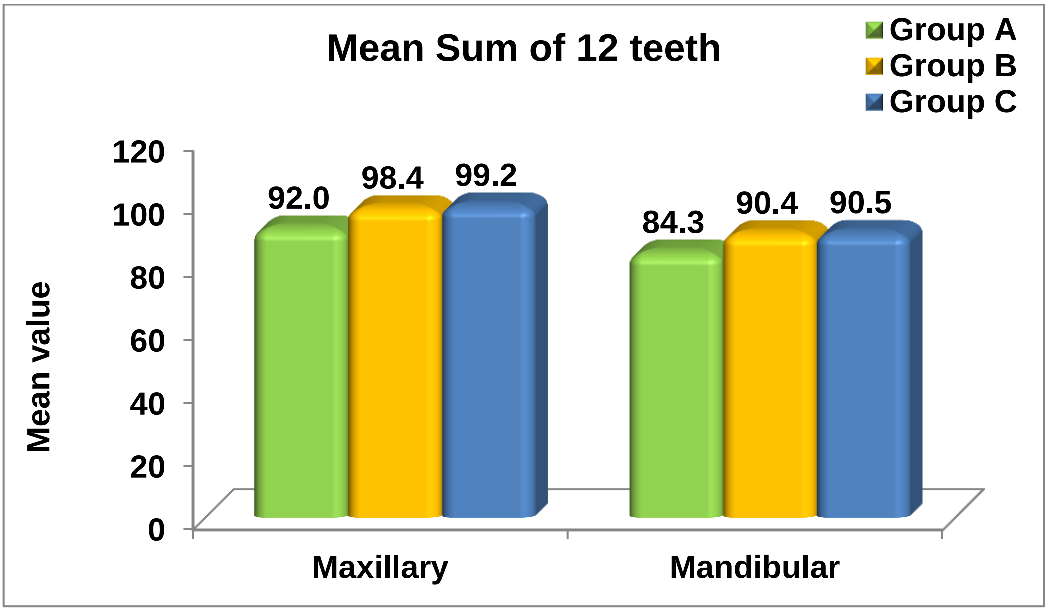
Variable	Pairs		Mean Diff	Sig.
Bolton ant ratio	Group A	Group B	-2.043	<0.001
		Group C	-2.053	<0.001
	Group B	Group C	-0.010	1.000
Over all ratio	Group A	Group B	0.207	0.547
		Group C	0.173	0.654
	Group B	Group C	-0.033	0.984

CHARTS

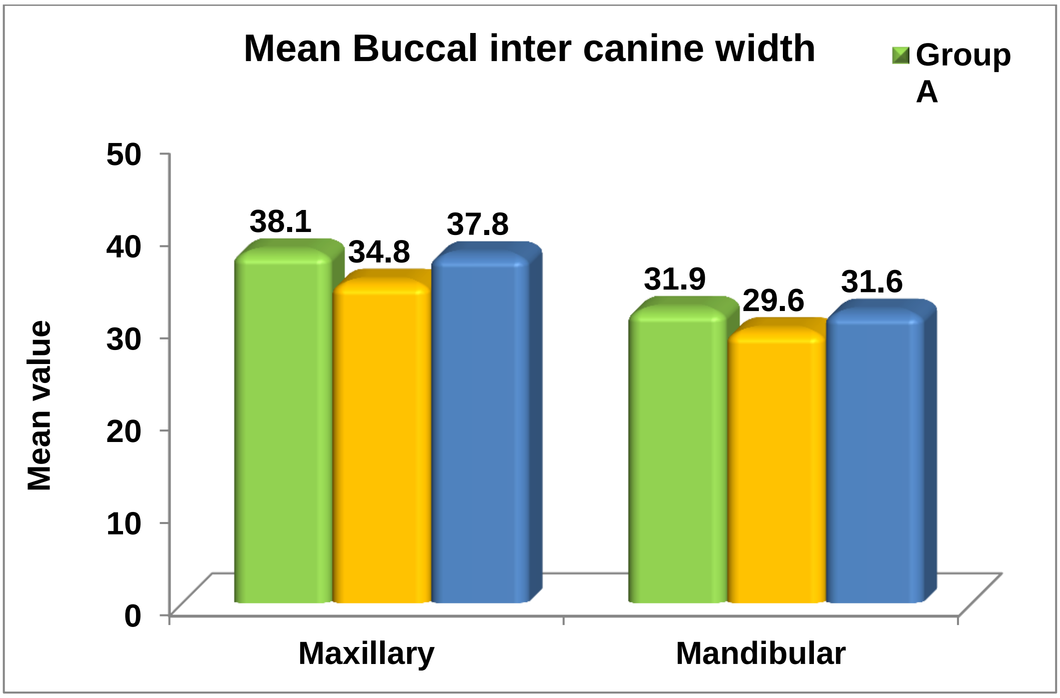
1) Sum of six Anterior –Maxilla and Mandible



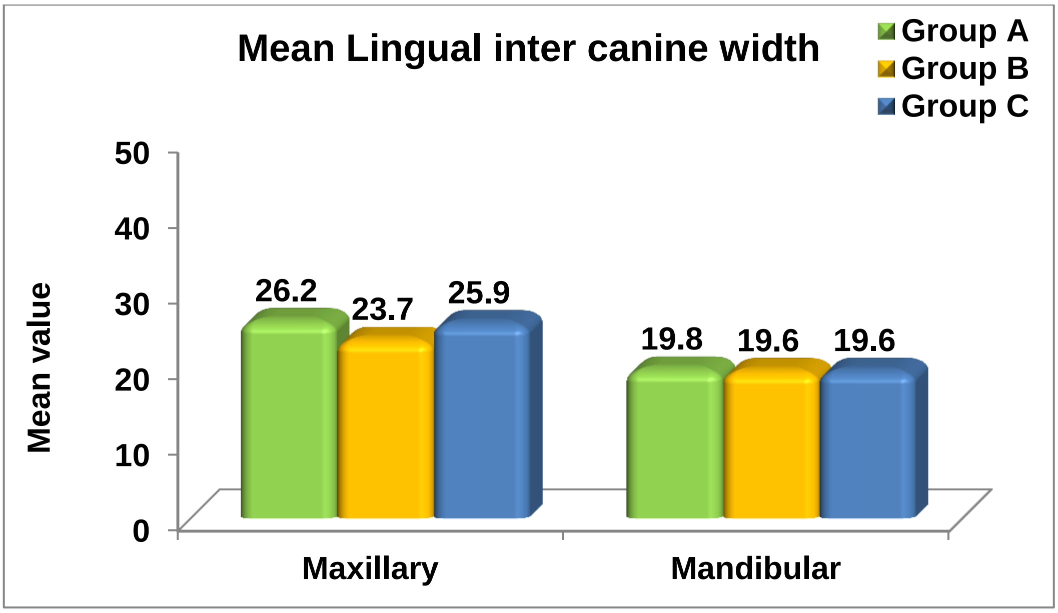
2) Sum of total 12 teeth –Maxilla and Mandible



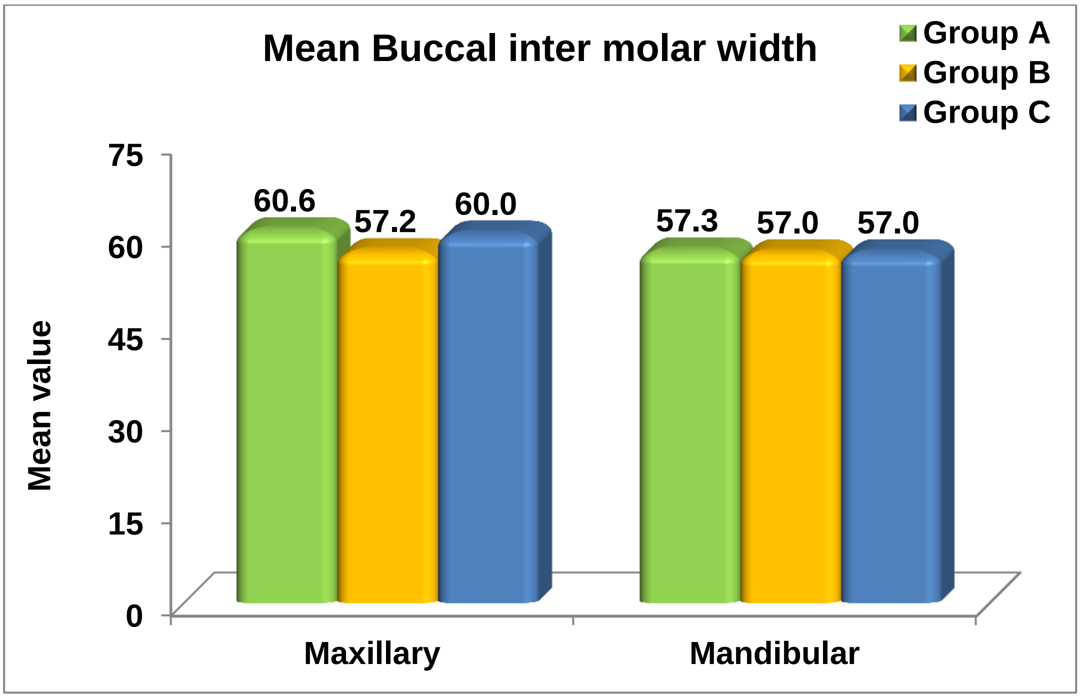
3) Buccal Intercanine width –Maxilla and Mandible



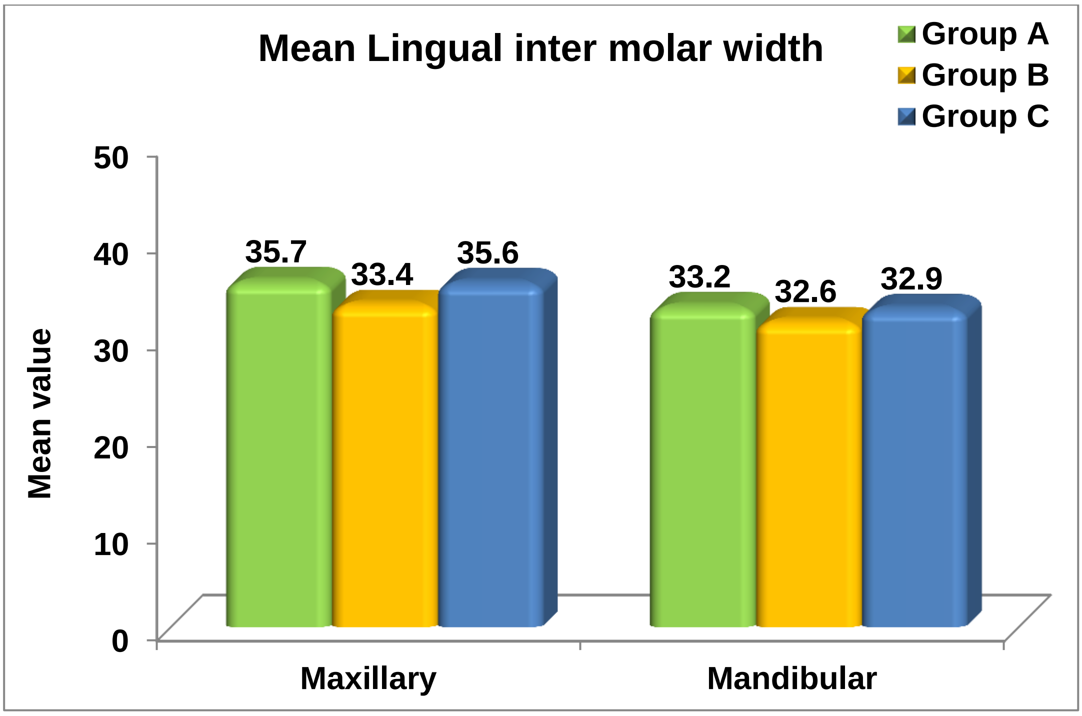
4) Lingual Intercanine width – Maxilla and Mandible



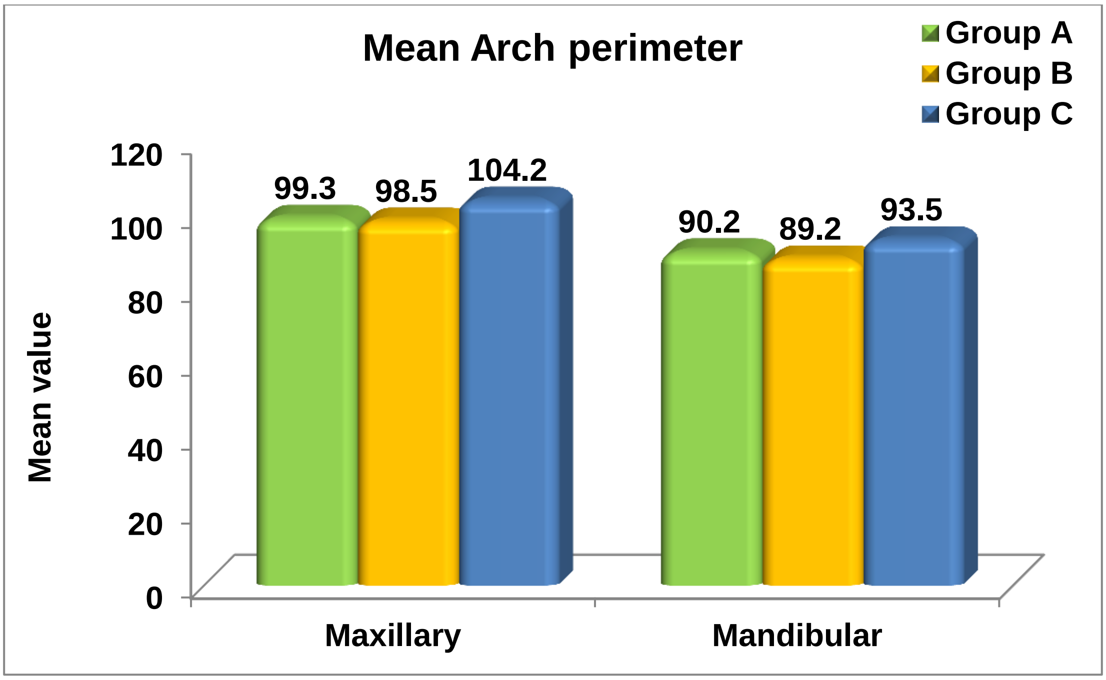
5) Buccal Intermolar width –Maxilla and Mandible



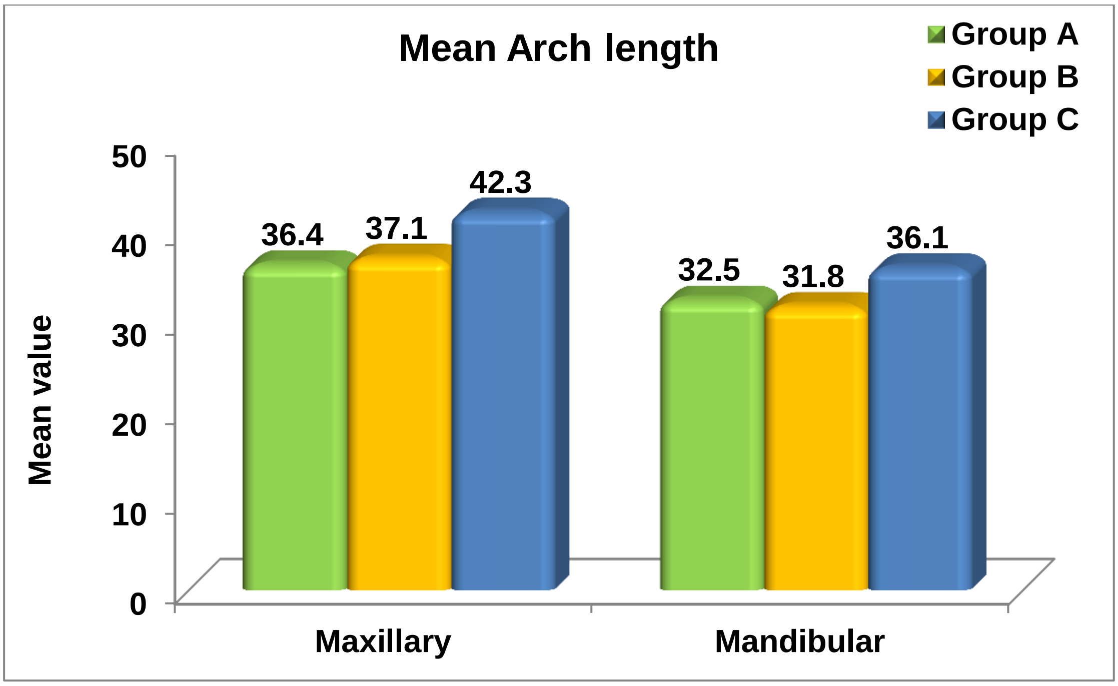
6) Lingual Intermolar width –Maxilla and Mandible



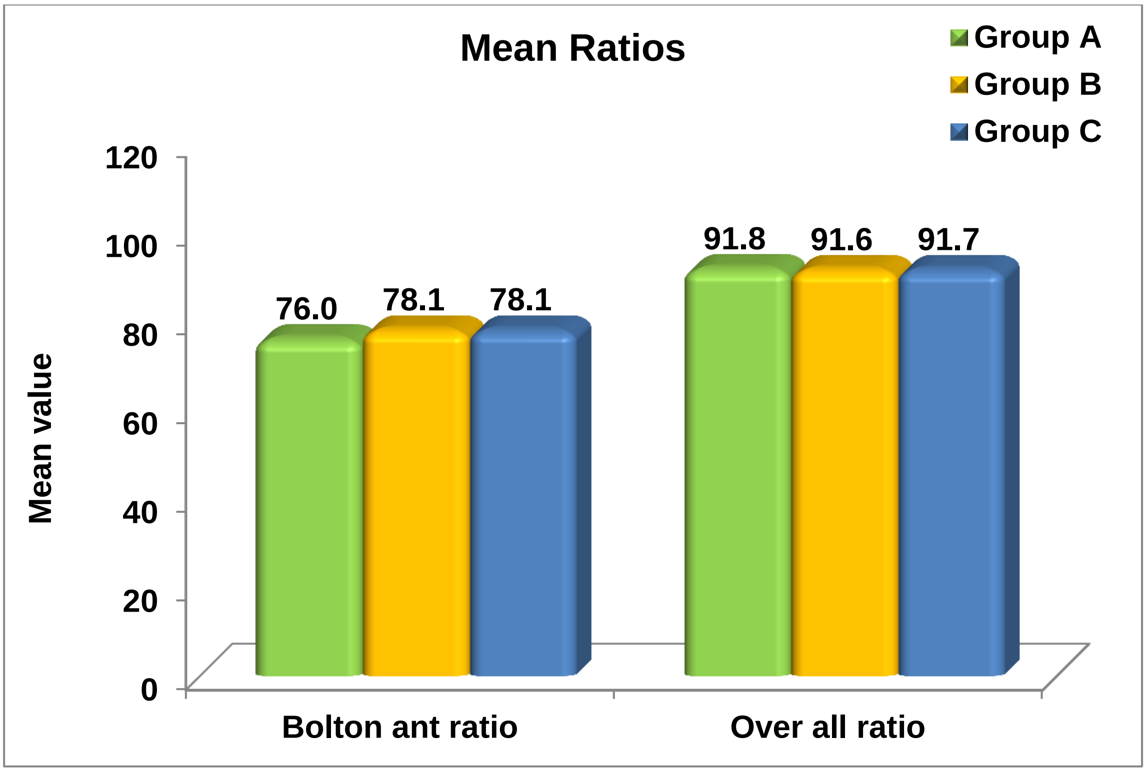
7) Arch Perimeter –Maxilla and Mandible



8) Arch Length –Maxilla and Mandible



9) Bolton's Anterior and Overall Ratio



Discussion

A meticulous treatment planning is the key stone for successful orthodontic treatment results. Since tooth size–arch dimension discrepancy is the most common etiology of dentoalveolar malocclusion, an understanding of the same is essential while planning treatment. Tooth size and arch dimension discrepancies are also considered to be an important variable in treatment outcome. Decision has to be made whether the tooth size needs to be reduced or the size of the dental arch needs to be increased in order to accommodate teeth in proper alignment.

Moorrees and reed[49] pointed out that a harmonious relationship between mesiodistal tooth dimension and arch length results in satisfactory alignment and optimum occlusion of teeth. Disproportion between these elements results in crowding or spacing in the dental arch.

Purpose of this study was to determine whether it is the mesiodistal teeth dimensions or the arch dimension such as inter canine alveolar widths (buccal and lingual), intermolar alveolar widths (buccal and lingual), arch perimeter and arch length contribute maximum to dentoalveloar malocclusions such as crowding and proclinations.

Vander linden[91] classified crowding on the basis of aetiology into primary, secondary and tertiary dental crowding. Primary crowding was defined as the inherent discrepancy between tooth size and jaw size which is mainly of genetic origin. Secondary crowding is that caused by environmental factors acting on it. Tertiary crowding is defined as crowding that develops in middle or late teens.

According to **Moorrees and reed[50],** the size of the tooth is dependent upon race and sex. Moorrees in his article ‘The Aleut Dentition’ has charted the tooth size of seven racial population groups namely Aleuts, Japanese, Chinese, Norwegian Lapps, Pecos Indians, Swedes, American whites. The general review of race as a source of tooth size variability indicates that tooth size varies with race. They stated that, it is apparent that race should be controlled in sample selection when considering for the study of tooth size. Accordingly in the present study, samples taken were from same race (Indian population).

Variation in tooth size according to sex has also been studied by **Garn et al[26]**, **Barrett et al[5] and moorrees and reed[49]. Garn et al[26]** found that tooth size, on an average, was 4 percent greater in males than in females. The greatest difference of 6 percent was found in mandibular canine and the least difference was found in mandibular incisors. **Barrett et al[5], moorrees and reed[49]** demonstrated this difference was evident regardless of race. Therefore in a study of tooth size, males and females should be reviewed separately whenever possible. In the present study, samples were taken equally from both genders (15 males and 15 females in each group) and variables were compared between them.

In this study, it was found that the combined mesiodistal teeth width of six anterior teeth and total twelve (first molar to first molar) teeth in the maxillary and mandibular dental arches were significantly greater in crowded groups of males and females when compared with normal group. These findings correlate with study results of **Fastlcht[23], Lundstrom[39], Doris et al[34] and Lombordi[2]** who found that the group with crowded arches consistently had teeth with larger mesio-distal dimension than in those with less or no crowding. Their findings also stated that large crown dimension are associated with crowded and proclined arches and reduction of tooth mass in arches could probably lead to a harmonious tooth size arch relationship.

Peck and Peck[62] found that buccolingual crown dimensions were actually larger in their perfectly aligned sample. They concluded that both mesiodistal and buccolingual crown dimensions were significant predictors of mandibular incisor crowding, although inversely related. Their results suggested that the ratio of mesiodistal to buccolingual tooth width was the most important predictor of Tooth Size Arch Size Discrepancy (TSASD) and that mesiodistal and buccolingual crown dimensions contributed independently to TSASD. Following this reasoning, one would be unable to distinguish whether greater mesiodistal or lesser buccolingual crown dimensions led to TSASD in a specific individual. Results from the present study suggest that larger mesiodistal crown dimensions of all types of teeth were positively correlated with crowding.

Lundstrom[39] using study models from twins reported that, for normal dental arches, the crowded teeth appear to result from a decrease in dental arch dimensions to the same degree as from an increase in the mesiodistal (MD) dimensions of teeth. However, the investigation was restricted to maxillary arch only. Some researchers including **Norderval K**[54]**, Peck S and Peck H**[62] found the same correlation with crown dimension and crowding, but others **Mills LF**[38]**, Howe R P**[31]**, Radnzic D**[16] found no correlation with findings of Lundstrom.

Results of **Doris et al**[34] study on tooth size comparison on crowded and non-crowded dental arches revealed a significant relationship between tooth size and arch alignment. They stated that, in maxillary arch, lateral incisors and second premolars showed significant difference between crowded and non-crowded groups. These two teeth show the greatest potential for influencing an arch, their increase in size being proportionate to the likelihood of an arch being crowded. In the mandibular arch, canines, first and second premolars showed significant differences in mesiodistal tooth size between crowded and non-crowded groups. Therefore one can use measurement of tooth mass as another aid in diagnosing border line case. When sum of the twenty teeth (from the second premolar to its antimere in both arches) is 140 mm. or greater, the clinician can label the case as one having larger than normal tooth mass and thus consider the need for extraction therapy. This, of course, must be considered in conjunction with the other diagnostic information, particularly the available arch length. In the present study mesiodistal tooth dimensions, arch length as well as arch perimeter was included for analysis.

Margret E Richardson[42] studied the role of the transverse dimension in late lower arch crowding. He followed fifty subjects, longitudinally between 13 and 18 years and showed an average increase in lower arch crowding by 2.36 mm. Their study did not support the concept that persons with wide dental arches and jaws are less likely to have crowding or are less susceptible to develop crowding after eruption of second permanent molars. Present study samples were taken after eruption of second molars. The transverse dimensions such as intercanine width and intermolar width were compared between the three groups i.e. Crowded, Proclined and Uncrowded and correlated with the type of malocclusion.

In this study, combined mesio-distal dimensions of six anterior and total twelve teeth of maxillary and mandibular arches were also found to be higher in crowded group when compared with uncrowded group. Contrary to this finding, **Howe et al**[31]**, Randzic**[16]**, Forseberg**[12] **and Gilmore**[13] did not find any significant correlation between mesio distal tooth size and crowding. They stated that crowding was related to dental arch dimension such as arch width, arch perimeter rather than mesio distal tooth dimension.

Howe et al[31] examined the extent to which tooth size and jaw size contributed to dental crowding. Based on the study, Howe et al did not find any significant difference in mesiodistal crown dimension in crowded and non-crowded groups. Instead they found that, dental arch dimension of two groups significantly differ. In their study, difference in the mean values of maxillary mesio distal tooth dimensions between crowded and non-crowded group were 0.7 mm. and in mandibular teeth dimensions it was 0.1 mm in males. In females, the values were 0.7 mm and 0.5 mm respectively, which did not reveal a significant difference between crowded and non-crowded groups. Arch dimension comparisons yielded significant difference between groups. Buccal and lingual arch widths were significantly higher in non-crowded group. Based on their study, Howe suggested that subjects with crowding were more likely to have smaller dental arches than subjects with little or no crowding. Howe suggested that consideration should be given to those treatment techniques which increase dental arch length than reduce tooth mass. In their study, sample size was not equal and male and female counterpart of each group was unequal. In the present study the number of samples in each group were equal and the number of males and females were also equal (each group consists of 15 males and 15 females).

Age group taken by Howe et al ranged from 9-44 years. As the range was more and age related variations in arch dimensions were likely, the results can not be considered to represent the actual arch dimension of a particular age group. In the present study, age range was 18 -24 years which is a comparatively narrow range. This narrow range age group was preferred, as in this age, a stable arch dimension and relationship would have got established. Moreover age related dimensional changes in arch and teeth size is not expected in this age group.

Findings of the present study also contradict those of **Shah *et al.*** (2003)[4]. Their study examined orthodontically untreated subjects with varying degrees of crowding and found no difference in "crown shape" (defined as the MD/BL Ratio).

Radnzic[16] carried out a study on primary dental crowding and found significant correlation between arch length and arch perimeter and to a lesser extent arch width to primary dental crowding or spacing which supports the findings of **mills[38], Mckeown[46] and Howe etal[31].** In their study the samples were from different ethnic groups. **Mckeown** studied 65 subjects and found greater correlation between dental arch size and crowding than between tooth size and crowding. But his samples were not from the same ethnic groups. In the present study, samples were from same ethnic group.

Gilmore[13] in his study examined the dental crowding that developed after the orthodontic treatment. He examined only the dimensions of the four mandibular incisors to evaluate dental crowding. In present study, the samples included had not undergone any previous orthodontic treatment and both six anterior and total twelve tooth dimension of maxillary and mandibular arches were analysed.

Lorren F Mills[38] did a study to determine if well-aligned dental arches in young adult males differ from crowded dental arches in width, length, or tooth size. He stated that, mean arch width in the second premolar region would make a good index of group scores for tooth crowding. His findings did tend to support the suggestion of Howe et al that, lack of arch width in the premolar area may be an important factor in malalignment. His findings did not show a relation of tooth size or arch length, mesial to second molar, to alignment. Samples of his study were young adult midshipmen who might not represent the whole population.

Looking at the problem of dental crowding in a different way, **McCann and Burden (1996**)[45] investigated the role of tooth size in the aetiology of Bimaxillary dental protrusion. In this study, the mesiodistal measurements of all teeth from first molar to first molar were made with a Baker Vernier microscope rather than callipers. They found that individuals exhibiting bimaxillary protrusion had 5.7% larger teeth (from first molar to first molar) than those without protrusion. McCann and Burden concluded that although tooth size may play a part, the aetiology of bimaxillary protrusion is complex, but, evidently, tooth size was a discernible risk factor. In the present study tooth dimensions, as well as arch dimensions were analysed and the results of the study corroborate with their findings.

While evaluating width of the maxillary alveolar arch in canine and molar region, it was significantly reduced in crowded group than uncrowded and proclined group. In mandibular arch, mandibular buccal intercanine width was significantly reduced in crowded group in comparison with other two groups. This may be due to prominent buccal canine root areas in well aligned arches.

In this study, no significant difference was found in both maxillary and mandibular alveolar arch width form between the proclination and uncrowded group. This may be because the larger tooth dimensions in the proclination group may cause the arch to lean forward due to inadequate external lip pressure that restricts anterior movement of teeth.

Maxillary and mandibular arch perimeters and arch length were not significantly different between crowded and uncrowded group. The proclination group had significantly higher arch perimeter and arch length than crowded and normal group. This may be due to greater mesio-distal dimensions of teeth which occupy a greater circumference of arch than a normal occlusion.

Adams[1] made a comparison of the sum of tooth widths for each arch according to sex but also considered second molars. He stated that, in general there were significant differences in the tooth widths for male individuals in both arches and for female individuals in the upper arch. He considered the second permanent molars for each arch sum, and he also used a sample of subjects with class I posterior relationships. The author analysed tooth width in general and no mean crowding was quantified for the sample. This present study evaluated the tooth width as well as arch dimensions in crowded, proclined and uncrowded dentition.

While comparing the Bolton's ratio, significant difference was found between anterior ratios. The overall ratios were not significant between groups. This may be due to unequal mesio-distal dimensions in the anterior region of crowded and proclined group when compared with normal group. The present study results corroborate with the results of **Norderval et al**[54]**,** who evaluated anterior tooth width ratios in crowded and noncrowded cases. They also found a higher anterior ratio in the crowded cases. But the present study results do not corroborate with the findings of **Eduardo Bernabe et al**[19] who also studied the tooth width ratios in crowded and in non-crowded dentitions. Their study compared tooth width ratios in 143 adolescents with crowded or spaced arches. They stated that, no difference existed between tooth width ratios according to sex or interaction between sex and crowding.

The present study suggests that tooth size to a greater extent and maxillary arch dimensions to a lesser extent in crowded group contribute to crowding of dental arches. The greater tooth size and larger arch length contribute to proclination of dental arches in the proclination group. This shows that mesio distal tooth size mainly contribute to malocclusion like crowding and proclination of dental arches. The results emphasize tooth mass reduction while planning the treatment of malocclusion like crowding and proclination. Stability of treatment results may be jeopardised if non-extraction protocol is chosen for the correction of such malocclusion.

SUMMARY AND CONCLUSION

SUMMARY

This study was conducted to determine if it is mesiodistal tooth dimensions or arch dimensions that contribute maximum for cause of dentoalveilar crowding and proclination. The variables were obtained from crowded, proclined and acceptable dentition groups. Results were ststistically analysed and following conclusions were made.

CONCLUSION

1. The mesiodistal teeth dimensions were significantly higher in crowded and proclination group.
2. Both inter canine width and inter molar width of maxilla were significantly reduced in crowded group than uncrowded and proclination groups.
3. Maxillary and mandibular arch perimeter and arch lengths were significantly increased in proclination group than crowded and uncrowded group.

BIBLIOGRAPHY

1. **Adams CP**. A comparison of 15 year old children with excellent occlusion and with crowding of the teeth, Angle Class I malocclusion, in respect of face size and shape and tooth size. *Swed Dent J Suppl.* 1982; 15:11–26.
2. **Angeilo M Lombardi**, mandibular incisor crowding in completed case, Am J Orthod Dentofacial Orthop, 1972, Vol 61 No 4, pp 374-83.
3. **Anthony A. Gianelly**, Arch width after extraction and nonextraction treatment, Am J Orthod Dentofacial Orthop 2003; 123:25-8.
4. **Anwar Ali Shah et al**, Incisor crown shape and crowding American journal of orthodontics 2003; 123; 5: 562-567.
5. **Barrett, M. J., Brown, T., and MacDonald, M. R**.: Dental observations on the Australian Aborigines: Mesio-distal crown diameters of permanent teeth, Aust. Dent. J. 8: 150-155, 1963
6. **Becker et al,** Maxillary tooth size variation in dentitions with palatal canine displacement. Eur J Orthod, 2002 Jun; 24(3):313-8.
7. **Benjamin G. Burris, Edward F. Harris,** Maxillary Arch Size and Shape in American Blacks and Whites Angle Orthodontist, 2000, Vol.70, No. 4, 297- 302.
8. **Bolton W A,** the clinical application of tooth size analysis, Am J Orthod Dentofacial Orthop 1962, 48; 504-529.
9. **Bolton W A,** Dishormony in tooth size and its relation to the analyasis and treatment of occlusion. Angle Orthodontist, 1958, 28:113-130.

10. **C. L .B Lavelle,** Variations in the secular changes in the teeth and dental arches. Angle orthod, 1973 vol 43, no 4, 412-421.

11. **C. L. B. Lavelle et al,** Dental arches in various ethnic groups. Am J Orthod Dentofacial orthop 1971 Vol. 41 No 4.

12. **Carl-Magnus Forsberg,** Tooth size, spacing, and crowding in relation to eruption or impaction of third molars Am J Orthod Dentofac Orthop 1988; 94:57-62.

13. **Charles A Gilmore and Robert M,** Little mandibular incisor dimension and crowding. Am J Orthod Dentofacial orthop1984 593-502

14. **Christopher J. Lux et al,** Dental Arch Widths and Mandibular-Maxillary Base Widths in Class II Malocclusions between Early Mixed and Permanent Dentitions Angle Orthodontist, 2003,Vol 73, No 6, 674-685.

15. **Coenraad F. A. Moorrees, Robert B. Reed,** Biometrics of crowding and spacing of the teeth on the mandible, Vol 12 iss 1, pages 77–88, March 1954.

16. **D Radnzic,** Dental crowding and its relationship to mesiodistal crown diameters ad arch dimensions, Am J Orthod Dentofacial orthop 1988; 94:50-56.

17. **David Normando,** A clinical photogrammetric method to measure dental arch dimensions and mesio-distal tooth size. Eur journal of orthodontics 2011; 33:721-726.

18. **Deepak Gupta, R. Matthew Miner, Kazuhito Arai, and Leslie A.** Will Comparison of the mandibular dental and basal arch forms in adults and children with Class I and Class II malocclusions, Am J Orthod Dentofacial Orthop 2010;138:10.e1-10.e8

19. **Eduardo Bernabe et al,** Tooth Width Ratios in Crowded and Noncrowded Dentitions, *Angle Orthod* 2004; 74:765–768.

20. **Eduardo Bernabé, a César Eduardo del Castillo, a and Carlos Flores-Mirb,** Intra-arch occlusal indicators of crowding in the permanent dentition, Am J Orthod Dentofacial Orthop 2005; 128:220-5.

21. **Eduardo Bernabe, Carlos Flores-Mirb,** Dental Morphology and Crowding: A Multivariate Approach. Angle Orthod 2006; 76:20–25.

22. **Fahad F .H. Al sulaimani and Ahmed Rami Afify,** Bolton analysis in different classes of malocclusion in a Saudi Arabian sample. Egyptian Dental Journal, vol 52, no 2 2006; 1119:1125.

23. **Fastlicht,** crowding of mandibular incisor Am J. Orthod. 1970 Vol 58 No 2, page 156-63.

24. **Francesco Pachıet al,** Head Posture and Lower Arch Dental Crowding, *Angle Orthod.* 2009; 79:873–879.

25. **Frohlich FJ.** Changes in untreated Class II type malocclusions. *Angle Orthod.* 1962; 32:167–179.

26. **Garn S M, Lewis A B, Kerewsky R S.** Sex difference in tooth size. J Dent Res 43: 306-307, 1964.

27. **Gary A. Carter, Mc Namara,** Longitudinal dental arch changes in adults. Am J Orthod Dentofacial Orthop 1998; 114:88-99.

28. **Graber TM, Vanarsdall RL, Vig KWL.** Orthodontics: Current principles and Techniques, 5th ed. St. Louis: Elsevier Mosby; 2011.

29. **Guilherme Jansona et al,** Relationship between maxillary and mandibular base lengths and dental crowding in patients with complete Class II malocclusions. Angle Orthod.2011; 81:217–221.

30. **Guvenc Basaran et al,** Intermaxillary Bolton Tooth Size Discrepancies among Different Malocclusion Groups. Angle Orthodontist 2006, Vol 76, No 1:27-30.

31. **Howe R.P., McNamara, O'Connor KA.** An examination of dental crowding and its relationships to tooth size and arch dimensions. Am J. Orthod.1983, 83:363-373.

32. **Jan Hendrickson,** Long term stability of dental arch form in normal occlusion from 13 to 31 years of age. Eur journal of orthodontics2001; vol 23:51-61.

33. **Joel Huth; Robert Newton Staley; Richard Jacobs; Harold Bigelow; Jane Jakobsen,** Arch Widths in Class II-2 Adults Compared to Adults with Class II-1 and Normal Occlusion, *Angle Orthodontist, Vol 77, No 5, 2007.*

34. **John M. Doris, Brentley W. Bernard, and Mladen M. Kuftinec,** A biometric study of tooth size and dental crowding, Am J Orthod Dentofacial Orthop 1981, Vol 79 No 3,page 326-336.

35. **Kevin M Cassidy et al,** Genetic influence on dental arch form in orthodontic patients. Angle orthod 1998; Vol 65 No 5:445-454.

36. **Khalaf et al,**Tooth size in patients with supernumerary teeth and a control group measured by image analysis system, Arch Oral Biol. 2005 feb;50(2):243-8.

37. **Loomba et al,** Arch perimeter - A Comparative Study, Asian Journal of Oral Health & Allied Sciences - Volume 1, Issue 1, Jan-Mar 2011

38. **Lorren F Mills,** Arch width, Arch length and tooth size in young adult males, Angle orthod1964 Vol 34 No 2.page 124- 29.

39. **Lundstrom,** The aetiology of crowding of the teeth and its bearing on orthodontic treatment.(expansion or extraction), Eur J orthodontics - 1951,pp 176-191

40. **M. Ozgur Sayin, Hakan Turkkahraman,** Factors Contributing to Mandibular Anterior Crowding in the Early Mixed Dentition. *Angle Orthod* 2004; 74:754–758.

41. **M. Ozgur Sayin, Hakan Turkkahraman,** Malocclusion and Crowding in an Orthodontically Referred Turkish Population. *Angle Orthod* 2004; 74:635–639.

42. **Margret E Richardson,** Late lower ach crowding: the role of the transverse dimension. Am J Orthod Dentofacial orthop 1995; 107:613-617.

43. **Martina Slaja et al,** Dental archforms in dentoalveolar Class I, II and III malocclusions. Angle Orthod. 2010; 80:919–924.

44. **Mary Lynn Merz,** Tooth diameters and arch perimeters in a black and a white population, Am J Orthod Dentofac Orthop 1991; 100:53-8.

45. **McCann J, Burden DJ.** An investigation of tooth size in Northern Irish people with bimaxillary dental protrusion. Eur J Orthod1996;18:617-21.

46. **Mckeown M** The diagnosis of incipient arch crowding in children. NZ Dent J 1981; 77; 93-6.

47. **Michael K. Agenter et al,** Influence of tooth crown size on malocclusion. Am J Orthod Dentofacial Orthop 2009; 136:795-804.

48. **Monique Rraberin et al,** Dimensions and form of dental arches in subjects with normal occlusions. Am J Orthod Dentofacial orthop 1993; Vol 104 No 1:67-72.

49. **Moorrees CFA, Reed RB.** Correlations among crown diameters of human teeth. *Arch Oral Biol.* 1964; 9:685–697.

50. **Moorrees CFA.** The Aleut dentition: a correlative study of dental characteristics in an Eskimoid people. Cambridge: Harvard University Press, 1957.

51. **Nagwa Helmy El-Mangoury et al,** Mandibular anterior crowding and periodontal disease. Angle Orthod.1987:33–38.

52. **Navgeet Puri et al,** Biometric study of tooth size in normal, crowded, and spaced permanent dentitions. Am J Orthod Dentofacial Orthop 2007; 132:279.e7-279.e14.

53. **Nikolaos Tsiopas,** A 40 years follow-up of dental arch dimensions and incisor irregularity in adults, EJO 2011 *doi:10.1093/ejo/cjr121*.

54. **Norderval K, Wisth PJ, Boe OE.** Mandibular anterior crowding in relation to tooth size and craniofacial morphology. Scand J Dent Res 1975; 83:263-73.

55. **Noriko Shigenobu et al,** Patterns of Dental Crowding in the Lower Arch and Contributing Factors-*A Statistical Study.* Angle orthod2007 Vol 77 No 2l: 303-310.

56. **Norman Thomas Speck,** A longitudinal study of developmental changes in human lower dental arches. Am J Orthod Dentofacial Orthop 1950; Vol 10; No 4; 215-228.

57. **Oded Zilberman et al,** Evaluation of the validity of tooth size and arch width measurements using conventional and Three-Dimensional virtual orthodontic models, *Angle Orthod* 2003;73:301–306.

58. **Olav Bondevik,** Differences between high- and low- angle subjects in arch form and anterior crowding from 23 to 33 years. European journal of orthodontics 2007; 29:413-416.

59. **Omar Gabriel da Silva Filho et al,** Dental Arch Dimensions in Class II division 1 Malocclusions with Mandibular Deficiency. *Angle Orthodontist, Vol 78, No 3, 2008; 466-474.*

60. **Otuyemi and Noar,** A comparison of crown size dimensions of the permanent teeth in a Nigerian and a British population. Eur J Orthod, 1996, dec; 18(6):623-8.

61. **P. H. Buschang, J. Stroud and R. G. Alexander,** Differences in dental arch morphology among adult females with untreated Class I and Class II malocclusion, EJO 1994 Vol 16 issue 1 page 47-52.

62. **Peck.H and Peck.S,** crown dimension and mandibular incisor alignment, Angle Orthod, 1972 vol 42 No 2, page 148-153.

63. **Pete E. Lestrel et al,** A quantitative approach for measuring crowding in the dental arch: Fourier descriptors. Am J Orthod Dentofacial Orthop 2004; 125:716-25.

64. **Poosti M, Jalali T.** Tooth size and arch dimension in uncrowded versus crowded Class I malocclusions. J Contemp Dent Pract 2007; 8:45-52.

65. **Proffit WR.** Contemporary orthodontics, 4th ed. St. Louis: Mosby Year Book, 2007.

66. **Qiong Nie and Jiuxiang Linb,** A comparison of dental arch forms between Class II Division 1 and normal occlusion assessed by Euclidean distance matrix analysis. Am J Orthod Dentofacial Orthop 2006; 129:528-35.

67. **Raquel H. W. Tibana,** Changes in Dental Arch Measurements of Young Adults with Normal Occlusion—A Longitudinal Study. *Angle Orthod* 2004; 74:618–623.

68. **Robert H. Biggerstaff,** The anterior migration of dentions and anterior crowding: A review. Angle orthodontist 1967; Vol 37 No 3; 227-240.

69. **Saglam AM et al,** A comparison of mesio-distal crown dimensions of the permanent teeth in subjects with and without fluorosis. Eur J Orthod. 2004 Jun; 26(3):279-81.

70. **Samir E bishara et al,** Arch length changes from 6 weeks to 45 years Angle Orthod, 1998, Vol 68 No 1, page 69-74.

71. **Samir E Bishara et al,** changes in dental arches and dentition between 25 and 45 years of age, Angle Orthodontist 1996, Vol 66 No 6, page 417-422.

72. **Samir E Bishara et al,** Changes in the maxillary and mandibular tooth size- arch length relationship from early adolescence to early adulthood- A Longitudinal study. Am J Orthod Dentofacial Orthop1989; 95:46-59.

73. **Samir E. Bishara,** Paymun Bayati and Jane R. Jakobsen Longitudinal comparisons of dental arch changes in normal and untreated Class II, Division 1 subjects and their clinical implications, Am J Orthod Dentofac Orthop 1996;110:483-9.

74. **Santoro et al,** Comparison of measurements made on digital and plaster models. Am J Orthod Dentofacial Orthop 2003; Vol 124 No 1; page 101-05.

75. **Seba AlHarbi et al,** Mathematical Analyses of Dental Arch Curvature in Normal Occlusion. *Angle Orthodontist, Vol 78, No 2, 2008 page 281-287.*

76. **Sercan Akyalcın et al,** Bolton Tooth Size Discrepancies in Skeletal Class I Individuals Presenting with Different Dental Angle Classifications. Angle Orthodontist, Vol 76, No 4, 2006 page 637-643.

77. **Seung-Hoon Rhee and Dong-Seok Nahm,** Triangular-shaped incisor crowns and crowding Am J Orthod Dentofacial Orthop 2000; 118:624-8.

78. **Sillman JH,** .Dimensional changes of the dental arches- Longitudinal study from birth to 25 years;Am J Orthod .1964; 50:824-842 .

79. **Staley RN, Stuntz WR, Peterson LC.** A comparison of arch widths in adults with normal occlusion and adults with Class II, division 1 malocclusion. Am J Orthod. 1985; 88:163–169.

80. **T.D. Foster,** A longitudinal growth of dental arches, Am J Orthod Dentofacial Orthop 1977; Vol 72 No 3:309-14.

81. **Tancan Uysal et al,** Dental and Alveolar Arch Widths in Normal Occlusion, Class II division 1 and Class II division 2, Angle Orthod 2005; 75:941–947.

82. **Timothy R. Kuntz,** Arch Widths in Adults with Class I Crowded and Class III Malocclusions Compared with Normal Occlusions Angle Orthodontist, 2008 Vol 78, No 4, page 597-603.

83. **Todd M. Walkow and Sheldon Peck,** Dental arch width in Class II Division 2 deepbite malocclusion, Am J Orthod Dentofacial Orthop 2002; 122:608-13.

84. **Toru Kageyama et al,** A morphological study of the relationship between arch dimensions and craniofacial structures in adolescents with

Class II Division 1 malocclusions and various facial types, Am J Orthod Dentofacial Orthop 2006;129:368-75.

85. **Toshihiro Yoshihara et al,** Effect of serial extraction alone on crowding: Relationships between tooth width, arch length, and crowding, Am J Orthod Dentofacial Orthop 1999; 116:691-6.

86. **Toshiya Endo et al,** Threshold for clinically significant tooth size discrepancy. Angle Orthod; 2009; 79(4); 740-6.

87. **Tung Yuen Ting, Ricky Wing Kit Wong and A. Bakr M. Rabie,** Analysis of genetic polymorphisms in skeletal Class I crowding, Am J Orthod Dentofacial Orthop 2011; 140:e9-e15.

88. **V. Paulino, V. Paredes, J. L. Gandia and R. Cibrian,** Prediction of arch length based on intercanine width. *European Journal of Orthodontics* 30 (2008) 295.

89. **Valerie Ronay,** Mandibular arch form: The relationship between dental and basal anatomy,Am J Orthod Dentofacial Orthop 2008;134:430-8.

90. **Van der Linden FP.** Theoretical and practical aspects of crowding in the human dentition. *J Am Dent Assoc.* 1974; 89:139–153.

91. **Virgenia B Knot,** Longitudinal study of dental arch widths at four stages of dentition. Am J Orthod Dentofacial Orthop 1972; Vol 42 No 4; page 387-394.

92. **W. Craig Shellhart et al,** Reliablity of Bolton tooth-size analysis when applied to crowded dentitions. Angle orthod 1995:65(5):327-334.

93. **Yuen *et al,*** Mesiodistal crown diameters of the primary and permanent teeth in southern Chinese--a longitudinal study Eur J Orthod, 1997, dec; 19(6):721-31.